ROLE OF CLINICAL AND BIOCHEMICAL PARAMETERS FOR PREDICTING OUTCOME OF NON - INVASIVE VENTILATION IN PATIENTS WITH ACUTE EXACERBATION OF CHRONIC OBSTRUCTIVE PULMONARY DISEASE

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DECLARATION

I hereby declare that the dissertation entitled **"Role of clinical and biochemical parameters for predicting outcome of non - invasive ventilation in patients with acute exacerbation of chronic obstructive pulmonary disease"** submitted for the Degree of Doctor of Medicine in M.D., Degree Examination, Branch XVII, TUBERCULOSIS & RESPIRATORY MEDICINE is my original work and the dissertation has not formed the basis for the award of any degree, diploma, associate ship, fellowship or similar other titles. It had not been submitted to any other university or Institution for the award of any degree or diploma.

Place: Chennai Signature of the Scholar

Date: 25.09.14 **(Dr.K. MAHESWARAN)**

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ABSTRACT

ROLE OF CLINICAL AND BIOCHEMICAL PARAMETERS FOR PREDICTING OUTCOME OF NON - INVASIVE VENTILATION IN PATIENTS WITH ACUTE EXACERBATION OF CHRONIC OBSTRUCTIVE PULMONARY DISEASE

BACKROUND:

NIV is applied to this group of patients suffering from increased work of breathing; we can reduce the duration of NIV and also prevent progression of this stage to acidosis. The key interest in our study is relating the outcome of NIV therapy with respect to association between respiratory rate, Electrocardiogram, Co morbidities, though previous others studies related the outcome NIV therapy with respect to arterial Ph and $PaCO_2$.

AIM OF THE STUDY:

1. To know the correlation between compensated type 2 respiratory failure patients with increased respiratory rate and work of breathing and NIV outcome (NIPPV success or failure) in a selected group of patients admitted in our hospital.

2. To evaluate the influence of parameters like sputum consistency, Electrocardiogram, Chest x ray and co morbidities on NIV therapy outcome in these selected group of patients.

3. To find out whether sputum consistency modifies the duration of NIV therapy.

RESULTS

Total number of 131 patients was enrolled in this study of which females were 32.1% and males 67.9%. Mean age of enrollment in this study is 54.85 (S.D ± 6.248). we record our finding that of 131 patients, 121 patients got improved with NIV treatment and remaining 10 patients failed to improve due to various reasons which are discussed below. Mean duration of NIV to revoke patients with acute exacerbation and increased respiratory rate to near normalcy was 19.44 hours. Duration of NIV treatment is depends upon following factors: Respiratory rate at the time of admission, Sputum consistency, and Current history of smoking, Presence of co morbidities like Corpulmonale, diabetes and coronary artery disease.

Conclusion:

If NIV therapy is administered earlier in patients with acute exacerbation of COPD, we can certainly reduce the duration of NIV treatment, duration of hospital stay, and thereby reducing cost of treatment.

We also strongly put forward that in patients with associated co morbidity failure rate is higher with NIV therapy and utmost care should be taken

Keyword- COPD, Non Invasive Ventilation, work of breathing

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a form of chronic airway disease that develops mostly due to chronic exposure to noxious stimuli of which the most common is smoking [1].

The following are valid points about COPD:

I. Complex mechanisms are involved in airflow obstruction, which leads to increased airway resistance.
II. COPD can affect airway, lung parenchyma, pulmonary vasculature and the lesion can correlate to change in pulmonary function tests and clinical appearance.
III. COPD is ranked fourth in worldwide case mortality rate and the disease is both treatable and preventable[1].
IV. Incidence of COPD is increasing year by year and many people die prematurely due to the disease or its complication.
V. A unique programme to fight against COPD was developed in 1998. This was known as global initiative for chronic obstructive lung disease with a cooperation of NIH, World health organisation and National Heart, Lung, Blood institute. Main aim of this initiative is to increase awareness about global burden of COPD, preventive measures involved and management of COPD.

According to WHO estimation in 2004, there were about 64 million people affected by COPD worldwide [2]. In the year 2005, case fatalities due to COPD accounts for about more than 3 million people, which is approximately around 5% of all death globally that year. Almost 90 % of deaths occurred in low and middle income group countries.Without any intervention to cut down the risk factors related to COPD, total death may increase by more than 30% in the next 10 years.

The recent study “Indian Study of Asthma, Respiratory Symptoms and Chronic Bronchitis” (INSEARCH) conducted from 12 urban and 11 rural sites which includes 85,105 men and 84,470 women reported that prevalence of chronic bronchitis is 3.49% (4.29% in males and 2.7% in females) in adults > 35 years, the national burden was 14.84 million [3]

INSEARCH study used questionnaire and Spirometry, hence itcorrelates poorly with symptoms. The drawback of this study is that it might miss asymptomatic individuals with earlyspirometric abnormalities which might be significant.

Another COPD prevalence study conducted in Pune by using post bronchodilator Spirometry and questionnaire, reportednearly 2-fold higher prevalence compared to INSEARCH study.

Another collaborative study conducted in rural Kashmir with subjects aged more than 40 years by applying BOLD protocol, concluded that the prevalence of Stage1 or higher COPD was 19.3% [4].

Clinical diagnosis of COPD is considered in patients who presented with chronic cough, breathlessness, increase in amount of sputum production, and exposure to causative factors for this disease. Spirometric lung function test is needed for diagnosis. The presence of obstructive lung disease is diagnosed by post bronchodilator FEV_1/FVC <0.70 and the severity of disease is assessed by Post bronchodilator $FEV_{1.}$

COPD assessment is important because it helps to assess severity of disease, predicts hospital admission, or death and risk of subsequent exacerbation.

Exacerbation of COPD is defined as"a*sustained worsening of the patient's condition, from stable state and beyond normal day-to-day variations, that is acute in onset and necessitates a change in regular medication in a patient with underlying COPD"*.

Acute exacerbation of COPD is due to either viral infection of upper respiratory tract or infection of the conducting airways like tracheobronchitis.The aim of treatment in COPD patients with acute exacerbation is to reduce current exacerbation and also to prevent the

development of further exacerbations. Medications used during acute exacerbation includes short acting beta 2 adrenergic agonists with or without anti cholinergic drugs.

COPD exacerbation can be prevented by simple measures like cessation of smoking, vaccination against influenza and pneumococcus, knowledge about how to use inhaled medication and treatment with long acting drugs such as anti cholinergics and beta $_2$ adrenergic drugs with or without inhaled form of corticosteroids. These measures reduce the number of acute exacerbations and hospitalization.

DONALDSON *et al [5]* study reported highest number of annual exacerbations occurring in patients with severe COPD (category III) than in patients with moderate COPD.

PAGGIARO *et al.* [6] predicted exacerbations based on FEV1, in which they found that patients with forced expiratory volume (FEV_1) >60% had 1.6±1.5 (mean±SD) exacerbations per year. It is increased to 1.9±1.8 in patients with post bronchodilator FEV_1 value between 59%–40% and 2.3±1.9 exacerbations in patients with post bronchodilator FEV_1 <40% predicted.

According to GOLD guidelines, indication for non-invasive mechanical ventilation in acute exacerbation of COPD includes [1]:

1. Respiratory acidosis (arterial pH < 7.35 and / or $PaCO_2$>6.0 kPa, 45 mmHg).
2. Severe dyspnoea with clinical signs characterized by fatigue of respiratory muscles, maximized work of breathing or both such as increased activity of accessory muscles, abdominal paradox, or intercostal muscle indrawing.

Guidelines for respiratory failure management in acute exacerbation of COPD are mainly based on arterial blood gas analysis. Failure and success of Non-invasive ventilation depends upon arterial pH. Among hospitalized patients with COPD majority suffer from increased work of breathing and a few percentages of patients are admitted with acidosis which occurs following long standing untreated increased work of breathing leading to need for mechanical ventilation. When NIV is applied to this group of patients suffering from increased work of breathing, we can reduce the duration of NIV and also prevent progression of this stage to acidosis. The key interest in our study is relating the outcome of NIV therapy with respect to association between respiratory rate, Electrocardiogram, Co morbidities, though previous

others studies related the outcome NIV therapy with respect to arterial Ph and $PaCO_2$.

Another important reason behind my interest in this study is to compare the association of sputum consistency and smoking duration of NIV therapy. This forms the basis for selection of group with increased work of breathing who had been hospitalized and studying the outcome of NIV on them.

REVIEW OF LITERATURE

COPD is a disease characterized by limitation of airflow that is not fully reversible even after treatment. The airflow limitation associated with an abnormal inflammatory response of the lungs to noxious particles and gases. COPD is usually a progressive disease.

Risk factors leading to COPD include genetic and environmental factors.

Risk Factors for COPD:

Environmental	Host based
Smoking	Genetic factors
Occupational exposure	Airway hyper reactivity
Air pollution	
Childhood respiratory infection	
Low socioeconomic status	

Environmental factors

Smoking is the most important risk factor for development of obstructive lung disease [7].

Other factors include outdoor air pollution, dusts and fumes exposure in occupational environment, inhalation of biomass smoke, second –hand smoke exposure and previous tuberculosis.

Tobacco smoking

A Swedish cohort study [8] and Denmark study[9] reported that population attributablerisk fordevelopment of COPD in smokers respectively as 76.2% and 74.6%. In India most of them are using *"BEEDI"*for smoking more than cigarette[10]. Compared to non-smokers ventilatory function, deterioration is common among smokers. In males average decline in FEV1 is approximately around 9 ml per year for each pack-year of smoking and for female it is 6 ml. 8-yr prospective study of working men in West London by Fletcher and Petoshowed that fall in FEV_1 in smokers will be faster than in non-smokers.

The study conducted among middle aged smokers with anFEV1 between 55 to 90 %of predicted (The Lung Health Study)[11] revealed that those who quit smoking will have an improvement in FEV1 around 200 ml compare to non-smoker within 5 years.

Occupation:

Chronic inhalation of particles and gases carries a greater risk for COPD. Although we are not able to estimate the correct prevalence of COPD among workers because most of the workers are smokers and those with COPD drop out from work. The American Thoracic Society states that 15% of COPD cases are due to occupational exposure. The incidence of COPD among construction workers, plastic manufacturing and utility workers has also been found to be increased.

Outdoor air pollution:

It is due to pollutants from industries and motor vehicles causing pathological changes in lung and airway. A previous study observed that higher traffic density is associated with increased risk of COPD in women. Ozone, nitrogen dioxide and particulate pollutants [12] may cause bronchial hyperactivity, airway oxidative stress, pulmonary and systemic inflammation.

Indoor air pollution:

Biomass smoke and environmental tobacco smoking exposure contribute to the development of COPD. Biomass (animal dung, crop residue and wood) are used for cooking in rural areas. The Meta analysis

shows that biomass exposure is associated with development of COPD in both men and women[13].

Childhood Lower Respiratory Tract Infections:

Since lung growth and alveolar development continues into early childhood, it is possible that lower respiratory tract infections during childhoodmight produce permanent damage or impair lung growth and development[14].

HOST FACTORS

Genetic factors

Polymorphisms of genes involved in *protease- antiprotease* balance, antioxidant function, inflammation,and immune responses have been implicated inCOPD.

In one study, a combination of both candidate gene and positional cloning approaches were used. Boston Early-Onset COPD study [15] evaluated a single nucleotide polymorphism (SNPs) in and around the transforming growth factor-β1 (TGF-β1) region located in chromosome 19q and found that it was linked to pre-bronchodilator FEV1in smokers. This study was later confirmed by National Emphysema Treatment Trial (NETT),which includes not only the initial phenotype of low pre-bronchodilator FEV1, but also the presence of radio graphically confirmedemphysema.

Alpha 1 antitrypsin deficiency[16] causes COPD mainly in the young individuals, which accounts for about 1-2 % of total causes of COPD.

Conditions suggesting alpha 1 anti-trypsin deficiency:

1. Early onset emphysema (age less than 45 years).
2. Emphysema in a non-smoker.
3. Emphysema predominantly in lung bases.
4. Family history of early onset emphysema or non-smoking related emphysema.
5. Bronchiectasis without any other aetiology.

Airway hyperresposiveness:

In COPD, airway hyper-responsiveness is associated with accelerated decline in FEV1.However airway hyper-responsiveness does not predict bronchodilator responsiveness.

Pathological changes:

Clinical features of COPD are mainly due to complex alterations in structure and function of small airways and alveolar tissues. Processes implicated in development of pathological changes includes inflammation, cell proliferation, apoptosis, altered phenotype of lung cells, and remodelling of the extracellular matrix.

Inflammation:

Inflammation occupies a central role in pathogenesis of COPD. Smoking and other type of inhaled particles cause recruitment of inflammatory cells to the lungs and airways leading to lung injury and disrupt the normal mechanism of lung repair. Inflammatory cells associated with lung injuries are neutrophils, eosinophils, macrophages, and lymphocyte.

Broncho alveolar lavage fluid collected from smokers contains many fold increase in macrophages compare to non-smokers [17]. Up regulation of macrophage inflammatory protein-1α (MIP-1α), interlukin-8(IL-8), interlukin-13(IL-13), γ-interferon, and monocyte chemo attractant protein-1(MCP-1) is seen in bronchial epithelium of COPD patients. Cellular and humoral immunity play a central role in pathogenesis of emphysema.

Proteinase-Antiproteinase imbalance:

Several proteinases are involved in pathogenesis of COPD. Serine proteinases, especially neutrophils elastase, and several matrix metalloproteinases especially collagenase, gelatinase B, macrophage elastase, and MMP-14 are involved in pathogenesis of COPD [18].

Oxidant-Antioxidant imbalance [19]:

Smokefrom cigarette causes release of free radicals like Reactive oxygen species by inflammatory cells leading to lung injury. Up to 20 mg of tar per cigarette may be deposited in lung during smoking.Per gram of tar contains (10) ^{17}stable, long living radicals. In vitro study done by Schaberget al (11) showed that airway neutrophils and alveolar macrophages generate more oxygen free radicals such as hydrogen peroxide, hydroxyl radicals, and superoxide radicals in smokers than non-smokers.

Smoker's lung has more iron than that of non-smokers, providing catalyst for the production of hydroxyl radicals from H2O2. Oxidants can modify and inactivate protein such as alpha 1 antitrypsin, secretory leucoprotease inhibitor [SLPI], and histone deacetylase 2(HDAC2), which is involved in glucocorticoid mediated anti-inflammatory responses. Free radicals mainly affect the polyunsaturated fatty acids in the cell membrane. Compared to non-smokers, bronchoalveolar lavage fluids of smokers have increased levels of products of lipid peroxidation.

Anti-oxidants will give protection against oxidative injury. Intracellular anti-oxidants are controlled by copper and zinc dependant superoxide dismutase found in the cytoplasm and a manganese dependant form in

mitochondria. H2O2 is eliminated by catalase and glutathione peroxidase.

Additional anti-oxidants are vitamin A and vitamin E, which are enriched in epithelial lining fluid.

Experimental evidence shows that mice which lack anti-oxidant regulator, nuclear factor E 2-related factor (Nγf-2) develop emphysema when they are exposed to cigarette smoking. Nγf-2 protects against the development of emphysema not only by regulation of oxidant – anti oxidant balance, but also reduces the airway inflammation and maintains protease anti proteases balance.

Apoptosis:

Kasahara et al, Tuder et al study showed that apoptosis has an important role in COPD pathogenesis. Recent study suggests that vascular endothelial growth factor (VEGF) signalling in alveolar endothelial cells or genetic down regulation of VEGF production in alveolar epithelium produces apoptosis [20]. The mechanism by which, apoptosis leads to emphysema is still not clear. In Caspase 3 animal study which shows that apoptotic cell found in smoker lung and emphysematous lung not in non-smoker. That apoptotic alveolar type 2 cells degraded elastin.

Mucus hyper secretion:

Mucus is secreted from sub mucosal glands and airway goblet cells. Mucus glycoprotein is the main component of mucus, which has core proteins such as serine and threonine, to which carbohydrate and Cysteine residues are attached. In COPD mucus secretion is altered leading to hyper secretion of MUC5B over typical MUC5AC form and increase in MUC2 form. Other changes in mucus layer include greater acidity, less mucus glucosylation, and decreased anti-microbial peptides. GOLD stage severity was strongly correlated with inflammatory cell infiltration in small airway than the luminal mucus hyper secretion

PATHOGENESIS OF COPD[21]:

Elastase-Antielastase hypothesis:

Lung elastic fiber

Destruction of lung elastic fibres is a key component in development of emphysema. Extracellular matrix of lung parenchyma is organized as 1.axial system 2.parenchymal system 3.peripheral system.

Axial system extends from central airway to alveolar ducts, Parenchymal system is formed by matrix of alveolar septae, and Peripheral system arises from visceral pleura and extends into alveolar septae. Distal to respiratory bronchiole, axial system forms helix encircling alveolar duct. Elastin is the main component of axial system

and these elastic fibres provide elastic recoil throughout respiratory cycle. Elastin is resistant to many proteinases, however many enzymes are capable of degrading elastin such as neutrophils elastase, proteinases 3, cathepsin G, MMP-9, MMP-12, cathepsin L and cathepsin S.

Lung collagen turnover:

Alveolar wall collagen degradation and abnormal collagen deposition in alveolar wall are involved in pathogenesis[22]. Because of interstitial lung collagenous degradation produces enlargement the pores of kohnand produces emphysema. In emphysematous lung the number of pores of kohn is high.

Proteinases-Antiproteinase imbalance:

Proteinases such as Neutrophil elastase, Matrix Metalloproteinase and Cysteine Proteinase are involved in pathogenesis of emphysema. Neutrophil elastase is stored in azurophilic granules as an active protein; Serine Proteinase plays a prominent role in pathogenesis of COPD. It is active against elastin and other extra cellular matrix as well as non-extra cellular matrix.

Matrix Metalloproteinase (MMPs) [23]

This family of enzymes is divided into two types based on site of secretion and membrane association. MMPs degrade extracellular matrix and modify many other substances. Membrane bound forms are

more resistant to inhibition to Antiproteinase than MMPs in pericellular spaces. MMP-8 and MMP-9 are stored in specific granules in neutrophils. Alveolar macrophages produce MMP2, 9, 12, and 14.

Cysteine proteinases:

Human alveolar macrophage produces cathepsin L and S. These enzymes work at acidic pH, but at neutral pH, cathepsin S retains about 25% of its elastolytic capacity, which is equivalent to action of neutrophils elastase activity.

Proteinases inhibitor:

Inhibitors of serine proteinases and tissues inhibitors of Matrix Metalloproteinase of COPD which includes both Chronic bronchitis and Emphysema.

Emphysema is defined as an enlargement of the air spaces distal to the terminal bronchioles, with destruction of their walls. Secondary pulmonary lobule is the functional unit of lung.

Centrilobular Emphysema

In centrilobular emphysema, initial site of destruction leading to development of emphysema is pores of kohn. In classical lesion respiratory bronchioles appears dilated and enlarged, alveolar duct and alveoli appears normal. Centrilobular emphysema commonly affects upper zone. Most affected segment is apical & posterior segment of

upper lobe and superior segment of lower lobe. In cases of severe Centrilobular emphysema, the destruction mayproceedtowards the periphery of the lobule, so that distinction between centrilobular and paraseptal emphysema because blurred.

Panlobular Emphysema

In panlobular emphysema distinction between alveolar duct and alveoli is lost& alveoli lose their sharp angles. The pores of Kohn are more uniform and inconspicuous than in centrilobular emphysema. Mild panlobular emphysema is difficult to diagnose. Pan lobular emphysema is seen in patients with $alpha_1$ antitrypsin deficiency, constrictive bronchiolitis, and obliterative bronchiolitis. Panlobular emphysema affects the lower lobe predominantly.

Paraseptal Emphysema

More distal part of the acinus is affected like alveoli and alveolar duct, emphysema is adjacent to the pleura**,** along lobular septa (paraseptal emphysema) and at the margins of lobules and acini.

Irregular Emphysema:

Irregular emphysema is almost invariably adjacent to a scar, so it is otherwise called as paracicatricial emphysema. Most scars within lungs are small so emphysema is limited in extent.

Chronic Bronchitis

In chronic bronchitis inflammation involves epithelium of central airway and mucus secreting cells. This inflammation leads to increased mucus secretion and decreased mucociliary clearance**.**

Diagnosis of COPD:

Physical examination and *chest imaging* are insensitive methods for diagnosis of COPD. Physical findings such as decreased breath sound; hyper resonant chest percussion and low lying diaphragm are specific for COPD. The distance between thyroid cartilage and sternal notch less than 4 cm in a smoker older than age 45Yrs is highly suggestive of the presence of COPD.

Dyspnoea is seldom a compliant until FEV1 falls below 60% of predicted.

Hyperinflation is common in moderate and severe COPD, it produces increase in residual volume and also increased ratio between residual volumes to total lung capacity. Hyperinflation may be beneficial in COPD by increasing lung volume, elastic recoil pressure, and also decreasing airway resistance there by preserving maximum expiratory airflow.

Hyperinflation causes increase in dyspnoea by:

1. Decreased apposition between the muscles of abdomen and the diaphragmatic muscle.
2. Flattening of diaphragm causes increased radius of curvature, thereby decrease in transpulmonary pressure.
3. Shorter diaphragm muscle fiber length causes decrease in the force of contraction.

During exercise hyperinflation worsens because of airflow obstruction during expiration. HIV/AIDS is also associated with premature emphysema.

Lung volume measured by *helium dilution method* and *nitrogen washoutplethysmography* shows elevated total lung capacity and residual capacity. The carbon monoxide diffusion capacity is decreased in patients who have an FEV1 less than 1.0 L.

Clinical features:

Physical findings usually appear in severe form disease only.

INSPECTION FINDINGS: Pursed lip breathing, barrel shaped chest (increase in anteroposterior diameter of the chest), Hoover sign--flattening of diaphragm produces contraction of muscles which causes inward movement of the chest wall.

PALPATION: Reduction in the movement of the chest.

PERCUSSION: Tympanic note heard due to hyperinflation of the lung.

AUSCULTATION: Decrease in respiratory sounds and expiration is prolonged, polyphonic wheeze during expiration.

Chest X Ray finding:

Postero-Anterior view:

1. Increased radiolucency.
2. Decreased peripheral blood vessel shadows.
3. Flattening of diaphragm.
4. Decreased cardio-thoracic ratio- cardiac diameter less than 11.5cm with vertical heart and lung seen below the heart.
5. Increased intercostal space.

Lateral view:

1. Increase in retro cardiac space.
2. Increased in retrosternal area- measurement taken between anterior aspect of ascending aorta and the posterior aspect of sternum 3 cm below manubriosternal joint.
3. Obtuse costophrenic angle.

Computer tomography:

CENTRILOBULAR EMPHYSEMA: ill-defined margin with areas of low attenuation area. In early stage of COPD usually affects upper

zone of lung, low attenuated areas closely related to centrilobular arteries. Lung surrounding the low attenuated area appears normal.

PANACINAR EMPHYSEMA: lung destruction is uniform and gives rise to generalize low attenuation density of lung. Panacinar emphysema affects the lower lobe predominantly.

PARASEPTAL EMPHYSEMA: sub pleural well-marginated low attenuation area with distinct hairline walls. This pattern resembles saw teeth appearance.

Emphysema can be assessed by using lung density index. In Gevenios et al study among COPD patients showed density of -950 HU providing an accurate estimation of COPD.

Goddard classification of COPD[24]:

1 point: scattered emphysematous lesion 1 cm or less in diameter.

2 point: large size Low Attenuation Area (LAA) due to the fusion of emphysematous lesions.

3 point: LAA occupies an even larger area by the more pronounced fusion.

4 point: most of the lung occupied by emphysema and only a small area of normal lung.

Visual evaluation of pulmonary emphysema [25]:

Right and left lung divided into six areas by upper, middle, and lower lung fields on both sides. Degree of severity of pulmonary emphysema is graded based on five-point scale

0 point: no emphysematous lesions.

1 point: occupies less than 25 % of the entire lung field.

2 point: occupying from 25% to less than 50% of the entire lung field.

3 point: occupying from 50% to less than 75% of the entire lung field.

4 point: occupying more than 75 % of the entire lung field.

Maximum total = 24 points.

Spirometric assessment:

Spirometry is essential for diagnosis of COPD, classification of severity and progression of the disease. For the diagnosis, post bronchodilator FEV1/FVC should be less than 0.70. Once airflow is established, the severity of the disease is based on the FEV1.

Classification of COPD severity	
Stage	Characteristics
Mild COPD	FEV1≥ 80% predicted
Moderate COPD	FEV1 50%- 79% predicted
Severe COPD	FEV1 30%-49% predicted
Very severe COPD	FEV1 < 30 % predicted

BODE index:

Body mass index, **O**bstructive ventilatory defect severity, **D**yspnoea severity, and **E**xercise capacity [26]

Variable	Points On the BODE Index			
	0	1	2	3
FEV1(% predicted)	>65	50-64	36-49	<35
Distance walked in 6 min(in meters)	>350	250-349	150-249	<149
MMRC dyspnoea scale	0-1	2	3	4
Body mass index	>21	<21		

2 year mortality in patients with BODE score greater than 7 is 30%; whereas score of 5 to 6 is associated with 15 percent mortality. Score less than 5 is associated with 10% mortality in 2 year period.

Assessment of symptoms:

In the past COPD was assessed mainly based on severity of breathlessness, so MMRC grading was in use. Now COPD is recognized as multisystem disease, so to assess the comprehensive symptom, two questionnaires were developed such as 1. CAT questionnaire (COPD Assessment Test) and 2.CCQ (COPD Control Questionnaire) which are in current use.

COPD Assessment Test[27]:

This test has an 8- uni dimensional measure to assess health status of COPD patient. CAT questionnaire is available in local languages and also through validated translations. Test very closely correlates with the SGRQ (St George's Respiratory Questionnaire)

COPD Control Questionnaire (CCQ):

CCQ has 10 items in questionnaire which can be self-administered and developed to assess clinical control in patients with COPD.

Assessment of Exacerbation Risk:

The best predictor of having frequent exacerbation is a history of previous events of treatment. Hospitalization for a COPD exacerbation has poor outcome and also increased mortality.

RISK OF COPD: placebo-limb data from TORCH[28], Uplift and Eclipse:

GOLD spirometric level	Exacerbations per year	Hospitalizations per year	3 year mortality
Mild	?	?	?
Moderate	0.7 – 0.9	0.11 – 0.2	11%
Severe	1.1 – 1.3	0.25 - 0.3	15%
Very severe	1.2 - 2.0	0.4 - 0.54	24%

Assessment of co morbidities:

COPD is a multi-system disease, so it has significant extra pulmonary effects such as loss of weight, nutritional deficiency and skeletal muscle dysfunction due to enhanced anaerobic metabolism.

Co morbidities associated with COPD patients:

Because of common risk factors, COPD patients will have more number of co morbidities like cardiovascular disease, atherosclerosis, hypertension, depression, pulmonary embolism and lung cancer. Comorbidity occurrence is independent of severity of airflow limitation which can occur at any stage of the disease.

Factors associated with poor survival in COPD

i. Low FEV1.
ii. Active smoking.
iii. Hypoxemia.
iv. Poor nutrition.
v. Presence of Corpulmonale.
vi. Resting tachycardia.
vii. Low exercise capacity.
viii. Severe dyspnoea.
ix. Poor health related quality of life.

Reduction of the inspiratory capacity has a prognostic significance that is independent of FEV1.

Management of stable COPD:

Once COPD is established, treatment should be based on individual disease severity.

Goals for treatment of stable COPD

Reduce symptoms:

1. Relieve symptoms.
2. Improve exercise tolerance.
3. Improve health status.

Reduce risk:

1. Prevent disease progression.
2. Prevent and treat exacerbation.
3. Reduce mortality.

Non pharmacological management of COPD

Patient group	Essential	recommended	Depending on local guidelines
A	Smoking cessation (can include pharmacologic treatment)	Physical activity	Flu vaccine Pneumococcal vaccine
B-D	Smoking cessation (can include pharmacologic treatment) Physical rehabilitation	Physical activity	Flu vaccine Pneumococcal vaccine

Reduction in exposure to risk factors:

Smoking:

Smoking is the culprit for the development of COPD, so cessation of smoking is the main goal for all COPD patients. Health care professional should provide information regarding smoking cessation messages.

Behavioural approaches:

Popularly referred as “the five A’s”--- Ask, Assess, Advice, Assist, Arrange.

Group counselling:

These programs includes lectures, group interactions and exercises on self-recognition of one’s habit

Gradual reduction VS Abrupt Abstinence:

In gradual reduction phase when their nicotine level falls below critical threshold level patients experience tobacco withdrawal symptom, and prolonged discomfort. Many taperers gradually return to their customary cigarette smoking level.

Abrupt abstinence will also experience tobacco withdrawal symptoms. After few weeks of complete abstinence they experience less frequent cigarette craving than gradual taperers.

Pharmacologic treatment:

1. Nicotine replacement therapy.
2. Drugs.
3. Nicotine vaccine.

Nicotine replacement therapy:

Varieties of nicotine replacement formulations are available in market. They are Polacrilex (gum), trans-dermal system, nasal spray, a variety of inhalers and nicotine toothpicks.

Drugs like bupropion and varenicline used in smoking cessation.

Bupropion as an antidepressant [29], it is believed to act through dopaminergic and noradrenergic signalling. Recommended dose is 150 mg daily for 3 days followed by 150mg twice daily.

Varenicline is an (alpha4)3(beta2)2 receptor partial agonist [30]. It inhibits and blocks some nicotine effect. As a partial agonist, it has the potential to mitigate some of the nicotine withdrawal symptoms.

Pharmacological drugs for COPD

Patient group	Recommended first choice	Alternative choice	Other possible treatment
A	Short- acting anticholinergic or short- acting beta2-agonist	Long –acting anticholinergic Or Long-acting beta2-agonist Or Short-acting beta2agonist and short-acting anticholinergic	Theophylline
B	Long-acting anticholinergic Or Long acting beta2-agonist	Long acting anticholinergic and long-acting beta2agonist	Short-acting beta2-agonist And/or Short acting anticholinergic Theophylline
C	Inhaled corticosteroid +long acting beta2-agonist Or Long-acting anticholinergic	Long acting anticholinergic and long acting $beta_2$agonist Or Long acting anticholinergic and phosphodiesterase-4 inhibitor Or Long acting $beta_2$-agonist and phosphodiesterase-4 inhibitor	Short acting $beta_2$-agonist And /or Short acting anticholinergic Theophylline
D	Inhaled corticosteroid+ Long acting $beta_2$agonist and/or Long-acting anticholinergic	Inhaled corticosteroid+ Long-acting $beta_2$-agonist and long-acting anticholinergic Or Inhaled corticosteroid+ long acting $beta_2$agonist and phosphodiesterase-4 inhibitor Or Long-acting anticholinergic and long-acting $beta_2$agonist	Carbocysteine Short acting $beta_2$agonist And /or Short acting anticholinergic Theophylline

Pharmacologic treatment:

Pharmacologic treatment for COPD will reduce symptoms, increase exercise tolerance, decreases the number of episodes and severity of exacerbation, thereby improving the wellbeing. But pathogenesis of COPD and the long term decline in lung function is unaltered by above drugs.

When drugs are given through inhaled route proper training about technique is essential for management. The inhaler therapy prescription depends upon the availability of drug, the skills and ability of the patient, cost, and the prescribing physician.

Bronchodilators:

Bronchodilators will improve the FEV1 by modifying tone of the airway smooth muscles, by this expiratory flow is improved by airway widening. So it reduces dynamic hyperinflation during exercise and rest. Toxicity is dose related.

Inhaler therapy is preferred, in which long acting bronchodilator is more efficacious than short acting drugs. Bronchodilators play central role in symptomatic management in COPD patients. Combination of different classes of bronchodilator drugs will improve efficacy and decrease the adverse effects.

Anti-cholinergic drugs:

Most commonly used drugs are ipratropium, oxitropium, Tiotropium. These drugs block the acetylcholine' and act on muscarnic receptors. Short acting drugs block M_2, M3 receptors andpre-ganglionic junctional transmission is modified. Long acting drugs block M_3 and M_1 receptors. Anti-cholinergic drugs act longer duration than $beta_2$ agonists. Those with short action have 8 hours of bronchodilator activity and long acting has 12 hours of action [32].

Beta $_2$-agonist:

$Beta_2$agonist causes relaxation of smooth muscle present in the airway mediated via beta2 receptors, causing increased cAMP. Short acting bronchodilators usually have 4 to 6 hours of action, long acting drugs have action of 12 or more hours. To improve the compliance of treatment long acting drugs are used once daily in the treatment of COPD. Study conducted by Gregory Feldman[31] shows 150 micro gram of once daily indacaterol is more compliant for the patients as well as less number of drop out. The only long acting beta agonist which has 24 hours of action is Indacaterol.

Study done by James et al[32] in COPD patients for comparison of Tiotropium and Indacaterol on trough FEV1 after 12 weeks of treatment and to evaluate safety and efficacy after 26 weeks of treatment.

They conclude that indacaterol more efficacious in bronchodilatation and has higher compliance than Tiotropium and placebo.

Adverse effect:

1. Produces resting sinus tachycardia, and precipitate cardiac disturbance in some patients.

2. Exaggerated somatic tremor.

3. Hypokalemia.

4. Tachyphylaxis.

Methylxanthines:

Xanthines act as non-selective phosphodiesterase inhibitors. Theophylline [34] produces bronchodilation by blocking adenosine action. It improves the diaphragmatic muscle contraction, prevents respiratory muscle fatigue, increases ventilatory drive andpotentiates catecholamine function.

Theophylline decreases cough by augmenting mucociliary clearance, reduces the late-phaseantigen responses, suppresses leukocyte activation, and inhibits of mast cell histamine release.

Corticosteroids:

The role of Corticosteroids in reduction of pulmonary and systemic inflammation is controversial, so use of corticosteroid alone in

management of stable COPD is not recommended. But some study demonstrates that regular use of corticosteroid will produce improvement in lung function, reducing the frequency of exacerbation; improving symptom, and quality of life.

Adverse effect:

Commonly encountered adverse effects of corticosteroids are Oral candidiasis, hoarseness of voice and skin bruising. Long term treatment is associated with osteopenia, and osteoporosis.

Differential diagnosis:

1. Bronchial asthma.
2. Bronchiectasis.
3. Diffuse pan bronchitis.
4. Obstructive bronchitis.
5. Congestive cardiac failure.
6. Sino bronchial syndrome.

Other treatments:

Oxygen therapy

In patients with hypoxemia, administration of oxygen for long duration (>15 hours in a day) improves their survival.

Long term oxygen therapy (LTOT) is indicated in the following conditions:

1. PaO_2 below 55 mmhg or SpO_2 ator below 88% with or without hypercapnia confirmed twice over three week period.

2. PaO_2 between 55 mmhg and 60 mmhg or SpO_2 of 88%, if there is evidence of pulmonary hypertension, polycythemia (hematocrit more than 55%) and congestive cardiac failure.

Resting saturation of more than 70 mmHg at sea level is likely to be safe to fly without oxygen supplementation. If patients saturation is less than < 70 mmHg oxygen supplementation is essential while air traveling

Surgical treatment:

Lung volume reduction surgery (LVRS)

LVRS is a surgical procedure by which 20 – 30% of lung mainly from apices is resected bilaterally. LVRS will reduce lung hyperinflation, making diaphragmatic muscles more effective pressure generators. LVRS increases the elastic recoil pressure so that it will improve the expiratory flow rate. Surgery is more effective in patients with upper lobe predominant emphysema and with low exercise capacity.

Bronchoscopic lung volume reduction surgery in COPD patients with air flow limitation of FEV1 15-45% and heterogeneous

emphysema on CT, demonstrated moderate improvement in respiratory function.

Lung transplantation:

Lung transplantation will improve the quality of life in patients with very severe COPD. Lung transplantation is limited by donor organ shortage.

Criteria for lung transplantation:

BODE Index score of 7-10 in patients with age under 60 years and with at least one of the following criteria are indicated for lung transplantation.

1) History of frequent exacerbation with a high $PaCO_2$>50mmhg.
2) Corpulmonale, pulmonary hypertension or both.
3) FEV_1<20% of predicted with DL_{CO}<20% of predicted.

Lung transplantation can be unilateral or bilateral depending upon the availability of donor lung.

Presence of chronic hepatitis B or C infection, multi organ failure, current smoking and recent malignancy are considered absolute contraindications for lung transplantation surgery.

Bullectomy:

Bullectomy is a very old surgical procedure used to relieve dyspnea in patients with COPD. Excision of bullae that is not

contributing to gas exchange is known as bullectomy. Presence of high $PaCO_2$, severe emphysematous lung and pulmonary hypertension are not a contraindication for surgery.

Acute exacerbation of COPD:

Defined as “A sustained worsening of the patient’s condition,from the stable state and beyond normal day-to-day variations, that is acute in onset and necessitates a change in regular medication in a patient with underlyingCOPD.”

We should exclude other causes of worsening of symptoms like congestive cardiac failure, pneumothorax, and pulmonary embolism. Frequency and severity of acute exacerbation of COPD depends upon medication administration, smoking status, vaccination and disease severity.

Impact of acute exacerbation of COPD:

1. Acute exacerbation of COPD will produces short term and long term impact on health status, the additional decline in FEV1 averagedapproximately about 7 to 8 mL/year.

2. Acute exacerbation of COPD is major source of health care expenditure, especially when patient is admitted for hospitalization.

3. Recurrent episodes of acute exacerbation will affect the health related quality of life. Following single episode HQOL(Health-related Quality

Of Life) improves over 26 weeks, acute episode has negative impact on health related quality of life.

Etiology of acute exacerbation:

1. Viral pathogens.
2. Bacterial pathogens.
3. Environmental exposure.

Viral pathogens:

Rhinovirus, Respiratory Syncytial Virus (RSV), and Influenza infection cause bronchial epithelial inflammation and elaborate various cytokines and inflammatory mediators (IL-8, Groα, and ENA-78) producing exacerbation of symptoms. In addition respiratory Syncytial virus and rhinovirus produceeotoxin, eotoxin-2, and CCL5. Other viral causes include Parainfluenzae, Corona virus, Meta pneumovirus, and adenovirus.

Bacterial pathogens:

Bacterial pathogens causing acute exacerbation includes non-typeable Haemophilus influenza, Moraxella catarrhalis, and Streptococcus pneumoniae, other infrequent causes include gram negative organisms likeHaemophilus parainfluenzaeand Pseudomonas aeruginosa, and gram positive organisms like Staphylococcus aureus.

Soler et al studied pathogenic growth from lower respiratory secretions of more severely ill patients with acute exacerbation treated

with mechanical ventilation by using protected specimen brush and BAL, and they identified bacterial pathogen in 42% of specimens and viral cause in 10% of patients.

Bacterial infection causes increased mucus secretion, purulence of secretion, impaired mucociliary clearance and airway epithelial injury.

Environmental factors:

Both particulate and non-particulate matter for example sulfur dioxide, ozone, black smoke, and nitrogen dioxidecauses acute exacerbation of COPD.

Evaluation of AE COPD:

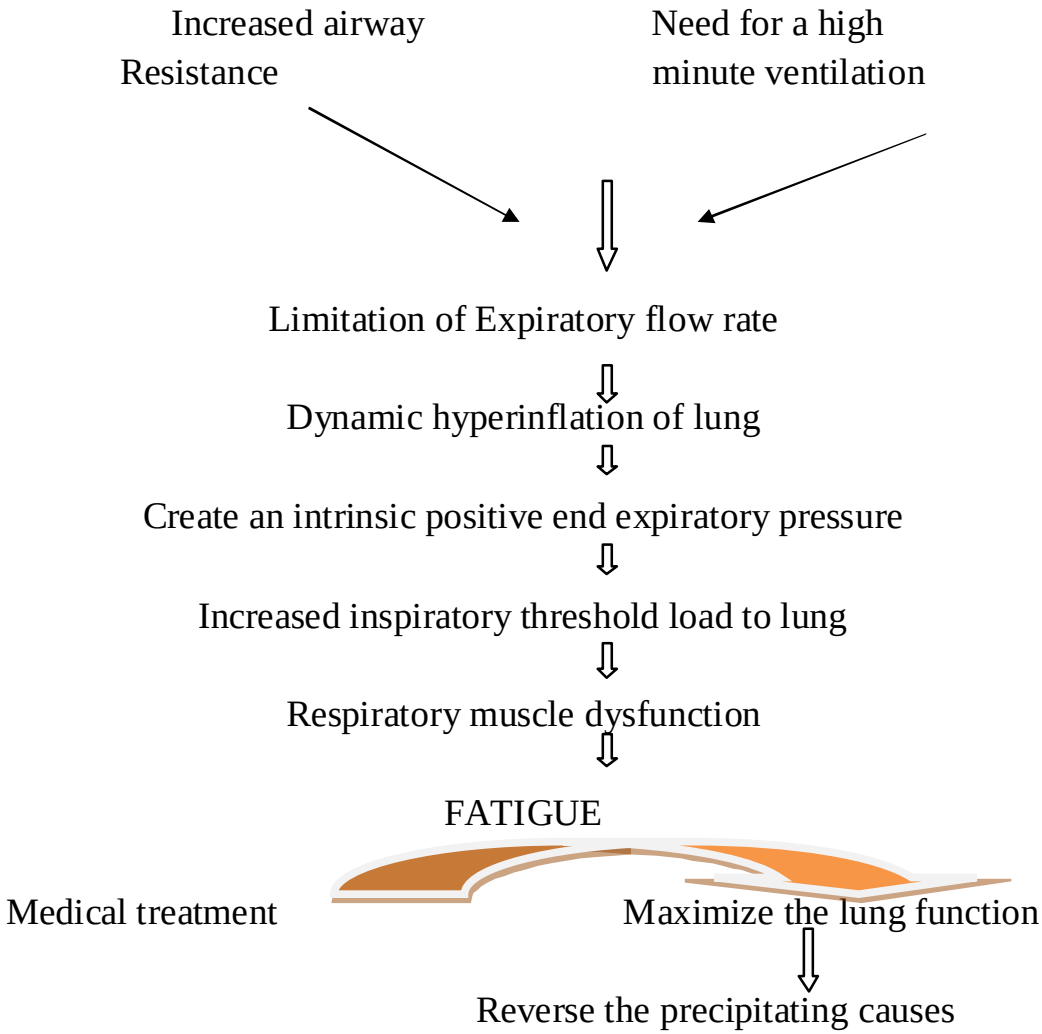
Clinical evaluation to identify the cause for exacerbation, and to rule out other causes for exacerbation like congestive cardiac failure, pneumothorax, and pulmonary embolism.

Pathophysiology of acute exacerbation of COPD:

The factors that favours Acute Respiratory Failure development during AECOPD depends on following:

a) Severity of precipitating cause.
b) Degree of physiological dysfunction.
c) Subsequent physiological reserve.

FACTORS LEADING TO FATIGUE OF RESPIRATORY MUSCLE:



Laboratory investigation:

Chest X ray:

It is used to identify the cause for exacerbation like Parenchymal infiltration, pneumothorax, cardiomegaly with pulmonary congestion and pulmonary embolism.

Arterial blood gas analysis is used for assessment of oxygen status, carbon dioxide level and pH of blood to decide about treatment plan.

Treatment:

During acute exacerbation of COPD,an imbalance is created between respiratory load and capacity of the lung, producing exaggerated inflammation in the airways leading to spasm of bronchus, edema of airways and more sputum formation. All this pathological changes will increase the airway resistance, and lead to increase in work of breathing. Patients tend to respond with rapid, shallow, largely ineffective breath, leading to increased dead space ventilation.

Non-invasive ventilation

Administration of positive or negative pressure ventilation to lung through either mask or similar device without intubation. NIV can be administered safely in ward itself; there is no need for intensive care unit. NIV decreases mortality in patients with acute exacerbation of COPD with arterial pH of < 7.35, $PaCO_2$> 45mmhg (uncompensated respiratory failure) after medical management. It is indicated in these patients not responding to optimal medical management.

Based upon pressure delivered by non-invasive ventilator it is divided into two types: Negative pressure ventilation and Positive pressure ventilation.

Till early 1960 only negative pressure ventilation was [35] used for NIV in patients with neuromuscular disorder likes poliomyelitis and deformity of chest wall. In this negativepressure was applied over chest through tank ventilator. Later positive pressure ventilation was in use for patients with respiratory failure. Initially positive pressure was given through endo tracheal tube alone.

Non-invasive positive pressure ventilation:

Acute pulmonary edema patients got relieved of respiratory symptoms by giving continuous positive pressure ventilation, which was demonstrated by AlvanBarach[36] in early 1930. By 1947, patients with acute respiratory failure where treated with intermittent positive pressure (IPP) ventilation. In NewYork (1960) Noninvasive positive pressure ventilation (NPPV) was administered nocturnally and in daytime it was used as and when neededin patients with neuromuscular disease atGoldwater Rehabilitation Center. Initially positive pressure was ventilation delivered through mouth piece.Later Nasal continuous positiveairway pressure (CPAP) was introduced in 1980sfor the treatment of obstructivesleep apnea. In 1984 Rideau and colleagues(19)

of Franceslowed disease progression of Duchene muscular dystrophy (DMD) using positivepressure ventilators which is confirmed by further studies which made NIPPV to gain importance in the treatment of chronic respiratory failure.

Reason for our interest in Noninvasive Ventilation:

Mostcommon reason for using non invasive ventilation is to avoid complication due to invasive ventilation.

- NIPPV provides greater flexibility in initiating and removing mechanical ventilation.
- While using NIV patient can eat, drink and communicate.
- NIV does not produce any effect on airway defence, speech, and swallowing mechanisms.

Complications due to invasive ventilation

1. The process of intubation and mechanical ventilation like injury to teeth, upper aerodigestive tract, arrhythmia, and hypotension.

2. Loss of airway defense mechanisms and impairmentof airway ciliary function facilitate an easy passage to themicroorganisms and other foreign materials to lower airways allowing their colonization leading to airway inflammation and damage.

3. After removal of the endotracheal tube- hoarseness of voice, sore throat, cough, sputum production, hemoptysis,upper airway obstruction and tracheal stenosis may occur.

EQUIPMENT AND TECHNIQUES FOR NONINVASIVE VENTILATION

In positive ventilation, available two modes are pressure-cycled and volume-cycled modes. In volume cycled mode [37] preset volume is delivered with each breath, irrespective of airway pressure. In volume-cycled mode compliance of patient is poor and possibility of air leakage is high.

Pressure cycled mode is more used than volume-cycle mode because preset pressure can be delivered during both phases of respiratory cycle, which can be either continuous positive airway pressure (CPAP) or bi-level positive airway pressure (BiPAP).

In CPAP, mode preset pressure is applied both during inspiration and expiration. BiPAP gives a high flow positive airway pressure continuously, which cycles between high and low positive pressures.In this type, triggering factor is breath of the patient leading to flow initiation from the ventilator. Inspiratory positive airway pressure (IPAP) and expiratory positive airway pressure (EPAP)are two pressure types delivered by the machine.

A pre-set amount of pressure whichis delivered during inspiration is known as inspiratory positive airway pressure (IPAP). Expiratory positive airway pressure (EPAP) is reached by closing the expiratory limb of the ventilator circuit whenthe airway pressure is less than the pressure determined as EPAP. This EPAP maintains positive pressure during expirationin the airways which is similar to PEEP in conventional ventilator, preventing collapse of alveoli.

Interfaces for the delivery of BiPAP or CPAP:

Tight fitting silicone made mask forms the interface between the patient and the machine. It must be of correct size so that it fits properlyover bridge of nose and chin of the patient preventing air leakage. Steps must be taken to prevent development of pressure sores over bridge of the nose.

Nasal masks:

The nasal mask interface is preferred over other types of interface during chronic applications. Commonly used nasal mask is triangular or cone-shaped clear plastic device that fits over the nose and utilizes a soft cuff to form an air seal over the skin; Nasal masks are available in different sizes.

Nasal mask[38] exerts pressure over bridge of nose causing irritation, redness and rarely ulceration. Straps that hold the mask in place are also important for patient comfort

Nasal "pillows" or "seals"*:*

If the patient who develops claustrophobia or nasal bridge irritation due to nasal mask, the alternative nasal device used is nasal pillow. It consists of soft rubber or silicone pledgets that are inserted directly into the nostrils

Oronasal masks:

As the name suggests, oronasal mask covers both the nose and the mouth. It is used mainly in patients with acute respiratory failure because it prevents copious air leaking through the mouth which occurs using nasal mask ventilation. Oronasal mask can also be used for chronic respiratory conditions.

Mouthpieces:

It is simple and inexpensive. During the daytime, patients may receive ventilatory assistance via a mouthpiece attached to their wheelchair controls.

Goals of Non Invasive Ventilation:

1. Relieve symptoms.

2. Reduce work of breathing by decreasing trans- diaphragmatic pressure.

3. Offset the effect of iPEEPby allowing the patient to take deeper breaths with lesseffort.

4. Improve gas exchange.

5. Minimize risk of barotraumas.

6. Avoid intubation.

Typical initial setting of non-invasive ventilation in patients with acute exacerbation of COPD[39] [40]:

1. Mode – spontaneous timed.
2. EPAP- 4 to 5 cmH_2O.
3. IPAP – 8 to 10 cmH_2O (increase upto 20 cmH_2O).
4. Trigger-maximum sensitivity.
5. Back up rate- 15 breaths/min.
6. Back up I: E ratio- 1:3.

Indication for Non-invasive ventilation:

I COPD

1. Respiratory acidosis ($PaCO_2$ >6.0 kPa, pH <7.35 or H^+ >45 nmol/l) which persists despite maximal medical treatment and appropriate controlled oxygen therapy.

2. Severe dyspnoea with clinical signs suggestive of respiratory muscle fatigue like increased work of breathing, use of accessory muscles, paradoxical motion of abdomen, and retraction of intercostal spaces

3. Facilitates weaning of intubated COPD patients from mechanical ventilator.

4. Extubation failure in COPD.

II. Chest wall deformity, neuromuscular disorder, decompensated Obstructive sleep apnoea.

III. Cardiogenic pulmonary oedema.

Contraindication for NIV:

1. Hemodynamic instability.

2. Life threatening hypoxemia.

3. Facial trauma/burns.

4. Recent facial, upper airway, or upper gastrointestinal tract surgery.

5. Fixed obstruction of the upper airway.

6. Inability to protect airway.

7. Impaired consciousness.

8. Copious respiratory secretions.

9. Undrained pneumothorax.

Predictor of NIV success in patients with respiratory failure:

- Hypercarbia (Pa_{CO2} < 92 mm Hg).
- No Severe Acidosis, pH > 7.10.
- Improvements in gas exchange and pulse rate and respiratory rate within first 1-2 hours.
- Young age.
- Lower acuity of illness (APACHE score).
- Able to cooperate; better neurologic score.
- When patient able to coordinate breathing with ventilator.
- Less air leaking, intact dentition

COMPARISON OF NIV AND INVASIVE VENTILATION:

POINTS	NIV	INVASIVE VENTILATION
Need and complications of intubation and tracheostomy	_	+
Ventilation associated pneumonia	_	+
Nosocomial infection	_	+
Efficacy	=	=

AIM OF THE STUDY

AIM OF THE STUDY

1. To know the correlation betweencompensated type 2 respiratory failure patients with increased respiratory rate and work of breathing and NIV outcome (NIPPV success or failure) in a selected group of patients admitted in our hospital.

2. To evaluate the influence of parameters like sputum consistency, Electrocardiogram, Chest x ray and co morbiditieson NIV therapy outcome in these selected group of patients.

3. To find out whether sputum consistency modifies the duration of NIV therapy.

MATERIALS AND METHODS

SITE OF INVESTIGATION:

Govt. Hospital of Thoracic Medicine, Tambaram Sanatorium, Chennai

STUDY PERIOD:

July2013 to July 2014

STUDY DESIGN:

Prospective observational study

STATISTICAL ANALYSIS:

By using Epi info[7] software

INCLUSION CRITERIA:

1) COPD patients with acute exacerbation with PaCO2 > *45* mmHg,pH (7.35 to 7.45) with increased work of breathing
2) Age >18 years.

EXCLUSION CRITERIA:

1) Diagnosis of asthma, sleepapnea syndrome or respiratory failure not due to COPD.

2)Patient with acidosis (arterial pH < 7.35).

3) Patients with shock with a systolic blood pressure of < 90 mmHg despite fluid challenge or need for vasopressor agents.

4)Altered conscious state (GCS < 8).

5) Copious respiratory secretions that could not be cleared easilyby the patients.

6) Recent myocardial infarction, unstable angina.

7) Recent facial trauma.

8) Upper abdominal surgery

METHODS:

1) Consecutive patients admitted with acute exacerbation of COPD with increased work of breathing and normal pH where recruited in this study. COPD was diagnosed with clinical examination, history, chest x ray finding, previous Spirometry.

2) Thorough history about smoking pack years, occupation, duration of symptom exacerbation, wheeze history, clinical examination like measurement of respiratory rate, heart rate, blood pressure, work of breathing, accessory muscle activity& pulse oximetry for oxygen saturation.

3) Taking Chest x ray PA view to look for COPD changes, cardiomegaly, Parenchymal infiltration, and pneumothorax. ECG for Corpulmonale changes & to rule out ischemia.

4) 1 to 2 ml of blood for haemoglobin estimation is collected to rule out anaemia and polycythemia.

5) Patient should be placed in a comfortable position and collect 2 ml of arterial blood from radial artery for blood gas analysis to assess $PaCO_2$ level, PaO2, and pH.

6) Procedureexplained to the patient about administration of Non-invasive ventilation, whenever possible attendees should also be included in the discussion.

7) Assess patients' heart rate, respiratory rate, blood pressure, sensorium, oxygen saturation, work of breathing and accessory muscle activity.

8) Optimum medical therapygiven to all patients with acute exacerbation before initiating NIV which includes:

I. Controlled oxygen delivered to the patient to maintain arterial saturation between 88–92%.

II. Administration ofnebulised salbutamol in a dose of 2.5–5 mg mixed with distilled water followed by nebulised ipratropium 500 µg given.

III.Prednisolone 30 mg tablet given through mouth, and antibiotic therapy if indicated.

NIV should be administered in patients with respiratory failure inspite of optimum medical management for more than 1 hour.

Before starting our study we ensured that the instruments are in working condition, proper motivation was given to patients to alleviate

their anxiety, nurses were given adequate training, tolerance of patient to mask ventilation was ensured, and possibility of air leakage in system circuit was checked.

To improve psychological support, relatives of the patients were allowed to stay with them and assist them whenever they needed any help. This is considered important to gain patient confidence and motivate them in pursuing therapy.

9)The patient was placed in a comfortable position like either sitting or semi-recumbent position in bed.Patient was connected to non-invasive ventilation, spontaneous –timed mode with low pressure setting of inspiratory pressure of 8 hpa, and expiratory pressure of 4 hpa, ramp of 10 minutes, rate depends upon patient respiratory rate. Low pressure settings will improve the patient compliance.

10) Oxygen is connected through side port of non invasive ventilator tube if patient saturation is less than 88%- 92%.

11) Interface is selected depending upon patient is comfort. During acute exacerbation Oronasal mask is the most preferred type of interface.

12) Once NIV is started patients comfort, breathing synchrony with ventilator and patient compliance are important in determining

outcome.Synchrony between the ventilator and the patient is checked frequently because patients comfort and compliance is important for outcome. A clinical assessment of correct fitting of mask over the Oronasal region and degree of leakage of air (particularly on to the corneas) should be checked then and there.

13) Once patient tolerates previous NIV settings, increment of IPAP should be done at a rate of approximately 5 cm H2O every 20 minutes, until upper limit of target pressure(20 cm H2O) is reached.

14) Reassess all the parameters after 1 hour to decide about tolerability of the patient and response to treatment.

15) Patient is monitored every 2 hours for first 12 hours and then every 4 hours for next 36 hours. Monitoring is important to decide about treatment escalation to intubation.

16) Bronchodilators administered preferably when patient is not connected to NIV machine, because delivery of both nebulized solutions and oxygen is affected by NIVpressure settings. If this is not possible then nebulizer can be connected between the expiration port and face mask.

17) As per BTS guidelines even if patients work of breathing is improved and respiratory rate becomes normal in a few hours, NIV

therapy is continued for a minimum duration of 6 hours in order to prevent relapse.

18) Patient who is still having increased work of breathing in 4 hours but improvement from baseline will continue NIV as much as possible in first day with break for food, and nebulisation.

19) If Patient shows response, NIV is continued on second day during night time only.

20) If patients condition is worsened (cardiac arrest or respiratory arrest, worsening of hypercapnia, loss of consciousness) from baseline, then mechanical ventilation was established.

Data recording:

Before administering NIV following parameters were recorded:

1. Age and sex of the patient
2. Childhood symptom
3. Seasonal exacerbation
4. Atopy
5. Sputum consistency (mucoid / mucopurulent)
6. Family history
7. Smoking index, current smoker (yes / no)
8. Sensorium

On examination:

1. Vital parameter like heart rate, respiratory rate, blood pressure, spo_2, were recorded
2. Work of breathing
3. Wheeze onauscultation
4. Electrocardiogram, chest x ray, arterial blood gas analysis

After administration of NIV the following data were recorded:

1. Duration of NIV.
2. Outcome

   Improvement defined as normalization of respiratory rate, no respiratory distress, normal heart rate, normal saturation, and work of breathing.

   Failure is defined as patient's intolerance to non-invasive ventilation, requiring mechanical ventilation for survival and death during non-invasive ventilation.
3. Duration of hospital stay.

ETHICAL JUSTIFICATION

The various investigations and procedures that will be used in this study will be as per protocol. The identity of each patient will be kept confidential. This study will not violate medical ethics in anyway and it will help to know the role of non-invasive ventilation in patient with acute exacerbation of COPD

RESULTS

RESULTS

Total number of 131 patients were enrolled in this study of which females were 32.1% and males 67.9%. Mean age of enrollment in this study is 54.85 (S.D ±6.248), minimum age of the patient is 42, maximum age is 75. Mean age for male patient is 57.07 and for female patient is 48.97.

		Frequency	Percent
Valid	Female	42	32.1
	Male	89	67.9
	Total	131	100.0

ATOPY:

None of the study group members had history of Atopy.

ATOPY HISTORY:

		Frequency	Percent
Valid	No	131	100.0

CHILDHOOD SYMPTOMS:

Childhood symptoms were present in one patient and who also had significant history of smoking.

CHILDHOOD SYMPTOMS:

		Frequency	Percent
Valid	No	130	99.2
	Yes	1	.8
	Total	131	100.0

FAMILY HISTORY:

None of study group members had family history.

FAMILY HISTORY:

		Frequency	Percent
Valid	No	131	100.0
	Total	131	100.0

SEASONAL EXACERBATION:

Seasonal exacerbation was found in 3 out of 131 patients.

SEASONAL EXACERBATION:

		Frequency	Percent
Valid	No	128	97.7
	Yes	3	2.3
	Total	131	100.0

Mean pack years for males was found to be 29.26.females included in our study were non smokers. They had exposure to second hand smoking and biomass fumes exposure making them vulnerable to COPD. Mean duration of symptoms for male was 16.40 (S.D $\pm$ 6.564). The mean duration of NIV was 19.44 (S.D $\pm$ 13.889). Mean duration of hospital stay was 9.06 (S.D $\pm$ 3.982)

		Age	Pack years	Duration of symp in days	Respiratory rate	Duration of NIV	Duration of hospital stay
N	Valid	131	131	131	131	131	131
	Missing	0	0	0	0	0	0
Mean		54.85	19.89	16.40	32.26	19.44	9.06
Median		56.00	30.00	14.00	32.00	26.00	9.00
Mode		56	0	10[a]	34	26	5
Std. Deviation		6.248	16.472	6.564	4.365	13.889	3.982
Minimum		42	0	7	26	1	4
Maximum		75	52	56	52	68	25

While assessing consistency of sputum, 17 out of 131 patients had mucopurulent sputum and the remaining had mucoid sputum. We found that consistency of that Sputum had impact on the outcome of study i.e. improvement of symptoms or failure of treatment. But also we found that consistency of sputum do have impact on duration of NIV i.e.

Patients with mucopurulent sputum had longer duration of NIV than patients with mucoid sputum.

SPUTUM PRODUCTION:

		Frequency	Percent
Valid	mucoid	114	87.0
	mucopurulent	17	13.0
	Total	131	100.0

SPUTUM PRODUCTION OUTCOME

			outcome		
			failure	improved	Total
Sputumproduction	mucoid	Count	8	106	114
		% of Total	6.1%	80.9%	87.0%
	mucopurulent	Count	2	15	17
		% of Total	1.5%	11.5%	13.0%
Total		Count	10	121	131
		% of Total	7.6%	92.4%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.473[a]	1	.492	.618	.382
Continuity Correction	.039	1	.843		
Likelihood Ratio	.420	1	.517	.618	.382
Fisher's Exact Test				.618	.382
N of Valid Cases	131				

Linear Regression (between sputum production and duration of NIV)

Variable	**Coefficient**	**Std Error**	**F-test**	**P-Value**
Sputumproduction (mucopurulent/mucoid)	13.087	3.437	14.4974	0.000216
CONSTANT	17.737	1.238	14.4974	0.000000

LINEAR REGRESSION (Packyears = durationof NIV):

Variable	Coefficient	Std Error	F-test	P-Value
Durationof NIV	0.227	0.102	4.8839	0.028873
CONSTANT	15.483	2.445	40.0927	0.000000

CURRENT SMOKING

Current smoking history is present in 8.4% of study population; current smoking history has influence on NIV duration and outcome of treatment.

CURRENT SMOKER:

		Frequency	Percent
Valid	No	120	91.6
	Yes	11	8.4
	Total	131	100.0

CURRENT SMOKER OUTCOME

			Outcome		
			failure	improved	Total
Current smoker	No	Count	7	113	120
		% of Total	5.3%	86.3%	91.6%
	Yes	Count	3	8	11
		% of Total	2.3%	6.1%	8.4%
Total		Count	10	121	131
		% of Total	7.6%	92.4%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	6.569[a]	1	.010	.039	.039
Continuity Correction	3.880	1	.049		
Likelihood Ratio	4.412	1	.036	.039	.039
Fisher's Exact Test				.039	.039
N of Valid Cases	131				

WHEEZE:

Except for two patients all members of the study population had wheeze on auscultation.

WHEEZE:

		Frequency	Percent
Valid	No	2	1.5
	Yes	129	98.5
	Total	131	100.0

CO MORBIDITY:

Seven members our study population had Co morbidities like diabetes, hypertension, Corpulmonale and coronary artery disease. Study also show that presence of Co morbidity has a significant influence on NIV outcome i.e. increased failure rate in NIV treatment.

CO MORBIDITY:

		Frequency	Percent
Valid	CAD	1	.8
	corpulmonale	3	2.3
	DM	2	1.5
	HT	1	.8
	nil	124	94.7
	Total	131	100.0

COMORBIDITY OUTCOME:

			outcome		
			failure	improved	Total
comorbidity	CAD	Count	1	0	1
		% of Total	.8%	.0%	.8%
	DM	Count	2	0	2
		% of Total	1.5%	.0%	1.5%
	HT	Count	0	1	1
		% of Total	.0%	.8%	.8%
	corpulmonale	Count	2	1	3
		% of Total	1.5%	.8%	2.3%
	nil	Count	5	119	124
		% of Total	3.8%	90.8%	94.7%
Total		Count	10	121	131
		% of Total	7.6%	92.4%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	53.491[a]	4	.000	.000
Likelihood Ratio	24.946	4	.000	.000
Fisher's Exact Test	27.449			.000
N of Valid Cases	131			

ACCESSORY MUSCLE ACTIVITY:

Increased respiratory rate was observed in almost all patients in our study group with increase accessory muscle activity except was one patient in whom muscle activity was not prominent due his obesity.

ACCESSORY MUSCLE ACTIVITY:

		Frequency	Percent
Valid	No	1	.8
	Yes	130	99.2
	Total	131	100.0

SENSORIUM:

Since altered Sensorium was our exclusion criteria, all our subjects had of normal sensorium.

SENSORIUM:

		Frequency	Percent
Valid	normal	131	100.0

ELECTROCARDIOGRAM:

Electrocardiogram was made as a mandatory investigation to our entire study group prior to NIV to exclude myocardial infarction. By doing this we detected three patients with Corpulmonale. ECG was also done during course of NIV treatment in isolated patients showing

symptoms and signs of MI. In this way we found patient with previous history of CAD on treatment and developed new MI leading to withdrawal of NIV therapy, showing that treatment outcome is poor in patients with co morbidities.*ELECTROCARDIOGRAM:*

		Frequency	Percent
Valid			
	normal	128	97.7
	p pulmonale	3	2.3
	Total	131	100.0

ECG OUTCOME:

			Outcome		
			Failure	improved	Total
Ecg	normal	Count	8	120	125
		% of Total	6.1%	91.6%	97.7%
	p pulmonale	Count	2	1	3
		% of Total	1.5%	.8%	2.3%
Total		Count	10	121	131
		% of Total	7.6%	92.4%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	15.345[a]	3	.002	.042
Likelihood Ratio	7.391	3	.060	.042
Fisher's Exact Test	9.505			.042
N of Valid Cases	131			

CHEST X RAY:

In chest x ray hyperinflation was predominant finding.

CHEST X RAY

	Frequency	Percent
hyperinflation	117	89.5
normal	11	8.3
hyperinflation with cardiomegaly	1	.8
pneumonia with hyperinflation	2	1.5
Total	131	100.0

CHEST X RAY OUTCOME:

Crosstab

			Outcome		
			failure	Improved	Total
Cxr	hyperinflation	Count	7	121	127
		% of Total	5.3%	92.5%	97.8%
	hyperinflation with cardiomegaly	Count	1	0	1
		% of Total	.8%	.0%	.8%
	pneumonia with hyperinflation	Count	2	0	2
		% of Total	1.5%	.0%	1.5%
Total		Count	10	121	131

Crosstab

			Outcome		
			failure	Improved	Total
Cxr	hyperinflation	Count	7	121	127
		% of Total	5.3%	92.5%	97.8%
	hyperinflation with cardiomegaly	Count	1	0	1
		% of Total	.8%	.0%	.8%
	pneumonia with hyperinflation	Count	2	0	2
		% of Total	1.5%	.0%	1.5%
Total		Count	10	121	131
		% of Total	7.6%	92.4%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	37.281[a]	5	.000	.002
Likelihood Ratio	16.715	5	.005	.002
Fisher's Exact Test	19.811			.002
N of Valid Cases	131			

OUTCOME:

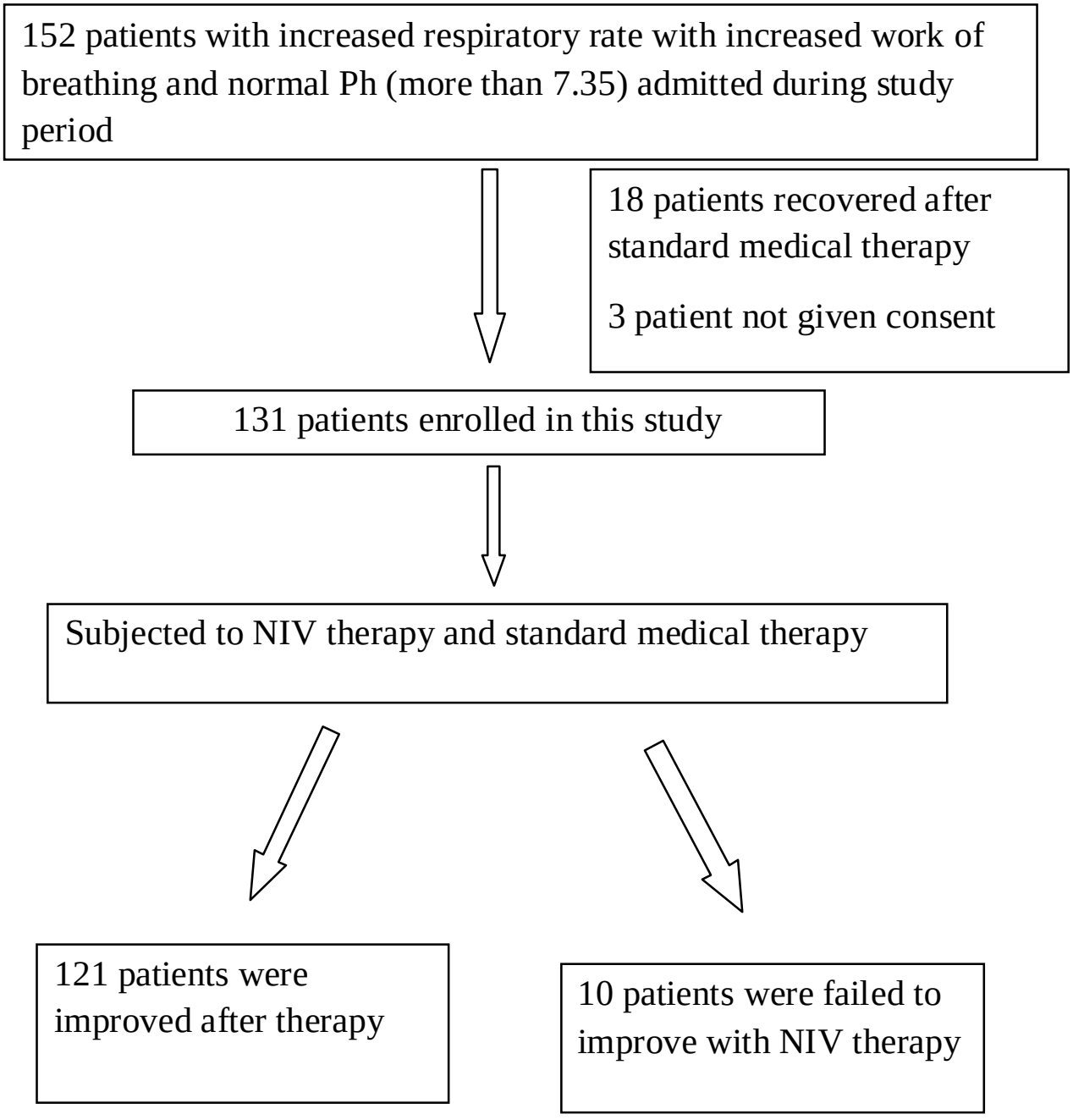
Finally we record our finding that of 131 patients, 121 patients got improved with NIV treatment and remaining 10 patients failed to improve due to various reasons which are discussed below.

OUTCOME

		Frequency
Valid	failure	10
	improved	121
	Total	131

In this tab various parameters are compared with regard to success and failure, 1 indicates successand 0 indicates failure.

outcome code		N	Mean	Std. Deviation	Std. Error Mean
Age	0	10	56.10	2.685	.849
	1	121	54.75	6.450	.586
Durationofsymptom in Days	0	10	18.00	6.360	2.011
	1	121	16.26	6.589	.599
Packyears	0	10	22.80	20.010	6.328
	1	121	19.64	16.222	1.475
Heartrate	0	10	111.70	7.543	2.385
	1	121	99.57	8.174	.743
Respiratoryrate	0	10	37.000	1.9437	.6146
	1	121	31.868	4.2816	.3892
Hb	0	10	11.890	1.1020	.3485
	1	121	11.498	.8123	.0738
Wbc	0	10	9500.00	2600.855	822.462
	1	121	8398.35	2065.268	187.752
Durationofhospitalstay	0	10	17.90	3.985	1.260
	1	121	8.33	2.990	.272


152 patients with increased respiratory rate with increased work of breathing and normal Ph (more than 7.35) admitted during study period
18 patients recovered after standard medical therapy
3 patient not given consent
131 patients enrolled in this study
Subjected to NIV therapy and standard medical therapy
121 patients were improved after therapy
10 patients were failed to improve with NIV therapy

REASON FOR FALIURE

		Frequency	Percent
Valid		121	92.4
	ACUTE MYOCARDIAL INFARCTION	1	.8
	ASSOCIATED CORPULMONALE	2	1.5
	CLAUSTROPHOBIA AND FIGHTING AGAINST VENTILATOR	4	3.1
	MECHANICALLY VENTILATED-DEATH	1	.8
	NECROTISING PNEUMONIA	1	.8
	PARAPNEUMONIC EFFUSION	1	.8
	Total	131	100.0

The above mentioned parameters are the important reasons that led to failure in our treatment.

DISCUSSION

In this prospective observational study totally 131 patients with increased work of breathing and increased respiratory rate (> 24/min) with normal Ph (>7.35) were enrolled in our study, of which32.1% were females and 67.9% were males. Mean age of enrollment in this study is 54.85 (S.D ±6.248), minimum age of the patient is 42, maximum age is 75. Mean age for male patient is 57.07 and for female patient is 48.97. The patients were subjected to NIV treatment in the general ward itself which was convenient, cost effective, feasible and alleviating need for intensive care settings.

COPD patients with acute exacerbation will have increased respiratory rate. If this stage is left untreated, the disease may progress to acute respiratory failure. When NIV is combined with standard medical treatment duration of hospital stay is reduced, recovery from illness is faster, thereby improving their disease outcome. Compared to stable COPD patients, unstable COPD patients are more prone for hypercapnic respiratory failure, hence there is need to start NIV therapy early. Reason for not administrating oxygen therapy in patients with spo2 > 88% as first line therapy is that such an act will blunt hypoxic ventilatory drive further worsening exacerbation. Hence patients with spo2 >88% were not subjected to oxygen therapy. In review of past studies we found that most of the studies were done in patients with

respiratory acidosis (ph 7.25-7.35) but relatively few studies are available on patients with ph> 7.35. In our study we have included COPD patients with acute exacerbation, ph>7.35 and documented NIV outcome with respect to success or failure in them.

In our study we followed BTS guidelines and set minimum duration of NIV therapy as six hours and made the following observations:

(a) In patients with respiratory rate ≤ 30, minimum of six hours of therapy was administered even if patients recovered earlier in order to avoid relapse.

(b) In patients with respiratory rate 30 – 40, NIV was administered during day time and sleep (excluding time for physiotherapy, nebulisation, and personal activities). If significant improvement with minimal increase in work of breathing, patient was supported with NIV during next day sleep alone, but if no satisfactory improvement is attained NIV is continued next day both during day and sleep till improvement is reached.(The maximum duration of NIV therapy observed in our study is 3-4 days)

While considering the intolerance level to NIV therapy among various studies, it is drawn that this rate is highly variable and the reason for which is not studied. Pertaining to this aspect we took much

effort to reduce the rate of intolerance, patients were given good counseling regarding positive benefits of receiving the therapy thereby alleviating their claustrophobia and anxiety. In spite of such an immense effort patients who were still fighting with ventilator, we set the escalation of inspiratory positive pressure (RAMP) at 20 min and slowly brought it down to their peer group rate. Thus achieving the goal of reduction in intolerance level. Above all these efforts, four patients continued to be claustrophobic, detaining from our study.

We found in our study that applying NIV therapy in patients with increase in respiratory rate adequately prevents them from progressing to acute respiratory failure, thereby reducing duration of hospital stay and need for mechanical ventilation. Mean duration of NIV to revoke patients with acute exacerbation and increased respiratory rate to near normalcy was 19.44 hours, duration of NIV treatment is individualized and depends upon following factors:

1. Respiratory rate at the time of admission
2. Sputum consistency
3. Current history of smoking
4. Presence of co morbidities like Corpulmonale, diabetes and coronary artery disease.

I would like to high light a few important parameters and their significance with duration of NIV therapy

Sputum consistency – patients with mucopurulent sputum had longer duration therapy compared to patients with mucoid sputum, and these patients with mucopurulent sputum had also received concomitant antibiotic therapy.

Pack years- not much significance has been observed

Current smoking – patients who smoke still datecoming with exacerbation when subjected to therapy we observed that duration of treatment and hospital stay is increased.

Co morbidities – compared to isolated patients with COPD, patients with co morbidities need close monitoring, additional nursing care, corresponding medical therapy thereby influencing outcome of therapy. As COPD is common among old age people as is true for co morbidities also, considering our outcome we strongly recommend that such patients need close observation in high intensive unit keeping in mind the possibility of need for mechanical ventilation.

We also studied the reason behind failure of NIV therapy in some patients in our group, finalizing our analysis here are the important reasons: Claustrophobia (4 patients), acute myocardial infarction

(1patient), associated corpulmonale (2 patients), diabetes with pneumonia complication (2 patients)

Patients with claustrophobia where treated with medical therapy and were closely monitored for signs of respiratory failure, they stayed in hospital for longer duration but finally got improved and were discharged. One patients with previous CAD history developed MI during course of NIV therapy hence NIV therapy was stopped, MI treatment was prioritized and medical therapy was continued.

Two patients with diabetes developed pneumonia, for them pneumonia was treated and NIV therapy was given for longer time. Two Patients with Corpulmonale required longer duration of NIV therapy.

Limitations of the study are:

My study is an observational study; we need a randomized control study to conform the influencing factor on NIV therapy

This study was conducted to know the outcome of NIV therapy in patients with acute exacerbation of COPD. Long term follows up and relapse rate were not studied.

Conclusion:

COPD with acute exacerbation is treated till now with medical therapy and ventilatory support. Our field has seen in recent past years few researches done on NIV therapy in patients with acute exacerbation of COPD with ph>7.35. This study is one among them. If NIV therapy is administered earlier in patients with acute exacerbation of COPD, we can certainly reduce the duration of NIV treatment, duration of hospital stay, and thereby reducing cost of treatment.

We also strongly put forward that in patients with associated co morbidity failure rate is higher with NIV therapy and utmost care should be taken to control co morbid conditions and start other options like mechanical ventilation whenever needed.

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ANNEXURES

INSTITUTIONAL ETHICAL COMMITTEE, STANLEY MEDICAL COLLEGE, CHENNAI-1

Title of the Work : Role of Clinical and Biochemical parameters for Predicting outcome of non-invasive ventilation in patients with acute exacerbation of chronic obstructive pulmonary disease.

Principal Investigator : Dr. K Maheswaran

Designation : PG in MD (TB & Respiratory Medicine)

Department : Department of TB & Respiratory Medicine
Government Stanley Medical College,
Chennai-01

The request for an approval from the Institutional Ethical Committee (IEC) was considered on the IEC meeting held on 07.02.2013 at the Council Hall, Stanley Medical College, Chennai-1 at 2PM

The members of the Committee, the secretary and the Chairman are pleased to approve the proposed work mentioned above, submitted by the principal investigator.

The Principal investigator and their team are directed to adhere to the guidelines given below:

1. You should inform the IEC in case of changes in study procedure, site investigator investigation or guide or any other changes.
2. You should not deviate from the area of the work for which you applied for ethical clearance.
3. You should inform the IEC immediately, in case of any adverse events or serious adverse reaction.
4. You should abide to the rules and regulation of the institution(s).
5. You should complete the work within the specified period and if any extension of time is required, you should apply for permission again and do the work.
6. You should submit the summary of the work to the ethical committee on completion of the work.

K Vasanthan 1/7/2014

MEMBER SECRETARY,
IEC, SMC, CHENNAI

UniqueKey	h	age	sex	durationofsympindays	atopyho	childhoodsymptoms	familyho	seasonalexacerbation	packyears	sputumproduction	currentsmoker	wheeze	comorbidity	accessorymusdeactivity	sensorium	heartrate	bp	respiratoryrate	paco2	pao2	ph	ecg	hb	durationofniv	cxr	wbc	outcome	durationofhospitalstay	reasonforfailure
1	munnusamy	65	male	14	No	No	No	No	30	mucoid	No	Yes	nil	Yes	normal	98	13080	40	36.7	62.4	7.38	normal	13.5	26	hyperinflation	8500	improved	7	
2	thiyachallam	52	male	10	No	No	No	No	35	mucoid	No	Yes	nil	Yes	normal	96	11070	27	32.6	63.4	7.39	normal	11.6	6	hyperinflation	9100	improved	4	
3	shankar	53	male	15	No	No	No	No	37	mucoid	No	Yes	corpulmonale	Yes	normal	98	12080	33	38.5	65.4	7.37	p pulmonale	13.6	48	hyperinflation	8600	improved	7	
4	murugan	45	male	25	No	No	No	No	10	mucopurulent	No	Yes	nil	Yes	normal	98	12070	28	41.6	67.8	7.36	normal	11.2	48	HYPERINFLATION	12500	improved	10	
5	VELLAYUDHAM	72	male	7	No	No	No	No	30	mucoid	No	Yes	nil	Yes	normal	88	12080	33	40.3	64.7	7.39	NORMAL	10.7	20	hyperinflation	8700	improved	6	
6	sakthivel	49	male	13	No	No	No	No	25	mucoid	No	Yes	nil	Yes	normal	104	13070	28	38.2	68.3	7.41	normal	12.3	6	hyperinflation	9100	improved	7	
7	kannan	75	male	14	No	No	No	No	0	mucoid	No	Yes	nil	Yes	normal	121	12080	40	28.4	62.5	7.42	normal	12.8	32	hyperinflation	11400	improved	10	
8	murugan	58	male	14	No	No	No	No	35	mucoid	No	Yes	nil	Yes	normal	127	11070	52	29.4	61.2	7.41	normal	12.4	44	hyperinflation	9300	improved	12	
9	krishnan	65	male	15	No	No	No	No	0	mucoid	No	Yes	nil	Yes	normal	123	12080	28	27.6	71.3	7.39	normal	12.3	6	hyperinflation	9600	improved	4	
10	ayyam perumal	69	male	21	No	No	No	No	32	mucoid	No	Yes	nil	Yes	normal	108	12080	33	32.4	68.4	7.4	normal	13.4	26	hyperinflation	10300	improved	6	
11	ramaraj	57	male	30	No	No	No	No	35	mucoid	No	Yes	nil	Yes	normal	88	13080	29	35.7	72.3	7.41	normal	12.3	6	hyperinflation	8700	improved	6	
12	dhanapal	60	male	10	No	No	No	No	30	mucoid	No	Yes	nil	Yes	normal	136	13090	42	34.5	68.2	7.42	normal	11.9	44	hyperinflation	8500	improved	8	
13	egambarm	52	male	25	No	No	No	No	37	mucoid	No	Yes	nil	Yes	normal	88	13070	36	36.3	62.6	7.43	normal	11.2	26	hyperinflation	9100	improved	10	
14	shanthi	52	female	10	No	No	No	No	0	mucoid	No	Yes	nil	Yes	normal	105	12070	34	37.2	64.3	7.41	normal	12.3	26	hyperinflation	11400	improved	8	
15	girija	42	female	12	No	No	No	No	0	mucoid	No	Yes	nil	Yes	normal	98	11070	28	35.4	65.3	7.39	normal	10.3	6	hyperinflation	8600	improved	12	
16	abirami	45	female	13	No	No	No	No	0	mucoid	No	Yes	nil	Yes	normal	102	10070	34	28.4	68.2	7.38	normal	10.6	26	hyperinflation	8500	improved	14	
17	rani	46	female	16	No	No	No	No	0	mucoid	No	Yes	nil	Yes	normal	96	12080	29	29.3	67.3	7.39	normal	9.8	6	hyperinflation	8700	improved	6	
18	bhavani	56	female	14	No	No	No	No	0	mucoid	No	Yes	nil	Yes	normal	114	11080	34	28.3	64.3	7.36	normal	9.6	26	hyperinflation	8600	improved	9	
19	munusamy	62	male	20	No	No	No	No	32	mucoid	No	Yes	nil	Yes	normal	108	13070	36	30.4	64.8	7.35	normal	11.6	26	hyperinflation	9200	improved	12	
20	knadasamy	59	male	15	No	No	No	No	34	mucopurulent	No	Yes	nil	Yes	normal	98	13090	36	31.4	67.2	7.38	normal	12.3	36	hyperinflation	13200	improved	16	
21	karthik	54	male	21	No	No	No	No	28	mucoid	Yes	Yes	nil	Yes	normal	96	12070	28	37.2	69.3	7.39	normal	11.4	20	hyperinflation	10400	improved	10	
22	shanmugam	61	male	18	No	No	No	No	30	mucoid	No	Yes	nil	Yes	normal	102	13090	32	38.4	62.7	7.4	normal	12.3	26	hyperinflation	6400	improved	10	
23	karupusamy	62	male	16	No	No	No	No	34	mucoid	No	Yes	nil	Yes	normal	96	12070	38	39.5	66.4	7.41	normal	10.4	26	hyperinflation	11400	improved	12	
24	marappan	63	male	22	No	No	No	No	32	mucoid	No	Yes	nil	Yes	normal	102	13080	34	36.7	65.7	7.39	hyperinflation	10.4	26	hyperinflation	11200	improved	15	
25	varathan	64	male	24	No	No	No	No	28	mucoid	No	Yes	nil	Yes	normal	106	13080	29	35.6	68.2	7.38	normal	11.4	6	hyperinflation	6700	improved	9	
26	chinnappan	56	male	18	No	No	No	No	32	mucoid	No	Yes	nil	Yes	normal	104	13080	36	37.2	69.2	7.39	normal	12.3	26	hyperinflation	5600	improved	13	
27	annamalai	55	male	20	No	No	No	No	28	mucoid	No	Yes	nil	Yes	normal	96	12070	32	36.9	63.6	7.36	normal	11.3	26	hyperinflation	7800	improved	10	
28	vijaya	50	female	10	No	No	No	No	0	mucopurulent	No	Yes	nil	Yes	normal	106	11080	31	36.8	62.4	7.35	normal	10.2	36	hyperinflation	11800	improved	15	
29	radhakrishnan	52	male	20	No	No	No	No	30	mucoid	No	Yes	nil	Yes	normal	102	12070	27	36.7	67.3	7.37	normal	11.2	6	hyperinflation	8600	improved	5	
30	rajeshwari	52	female	14	No	No	No	No	0	mucoid	No	Yes	nil	Yes	normal	94	12070	34	38.5	65.8	7.38	normal	10.1	26	hyperinflation	7800	improved	15	
31	jayachandran	56	male	24	No	No	No	No	34	mucoid	No	Yes	nil	Yes	normal	96	13080	29	41.6	66.9	7.37	normal	12.3	6	hyperinflation	7700	improved	7	
32	anand	52	male	26	No	No	No	No	26	mucoid	No	Yes	nil	Yes	normal	98	11070	30	42.6	71.3	7.38	normal	10.5	6	hyperinflation	7600	improved	7	
33	sathiya	43	female	12	No	No	No	No	0	mucoid	No	Yes	nil	Yes	normal	97	11080	34	40.1	62.8	7.39	normal	11.2	26	hyperinflation	7300	improved	9	
34	madappan	52	male	16	No	No	No	No	32	mucoid	No	Yes	nil	Yes	normal	108	14080	26	36.4	68.3	7.37	normal	11.3	6	hyperinflation	8200	improved	5	
35	andal	45	female	13	No	No	No	No	0	mucoid	No	Yes	nil	No	normal	92	13080	28	34.5	64.5	7.41	normal	12.2	6	hyperinflation	8300	improved	5	
36	ashokkumar	52	male	12	No	No	No	No	36	mucopurulent	No	Yes	nil	Yes	normal	104	13080	32	33.5	65.7	7.4	normal	10.3	30	hyperinflation	7600	improved	7	
37	pushpharani	47	female	12	No	No	No	No	0	mucopurulent	No	Yes	nil	Yes	normal	97	12080	30	36.3	67.5	7.4	normal	11.3	26	hyperinflation	5600	improved	7	
38	chandra	48	female	22	No	No	No	No	0	mucoid	No	Yes	nil	Yes	normal	84	12080	27	37.3	69.3	7.41	normal	11.5	6	hyperinflation	7800	improved	5	
39	pandiyarajan	54	male	24	No	No	No	No	35	mucoid	No	Yes	nil	Yes	normal	86	13080	34	27.4	63.6	7.41	normal	12.3	26	hyperinflation	6700	improved	7	
40	nandakumar	56	male	14	No	No	No	No	34	mucoid	No	Yes	nil	Yes	normal	92	12070	34	28.3	65.8	7.42	normal	12.3	26	hyperinflation	7900	improved	8	
41	raja	50	male	16	No	No	No	Yes	30	mucoid	No	Yes	nil	Yes	normal	96	12080	27	31.4	67.2	7.43	normal	11.9	6	hyperinflation	6700	improved	5	
42	sakthivel	62	male	17	No	No	No	No	38	mucoid	Yes	Yes	nil	Yes	normal	98	13080	26	36.2	61	7.44	normal	10.3	6	hyperinflation	7500	improved	5	
43	chinnarasu	48	male	10	No	No	No	No	28	mucoid	No	Yes	nil	Yes	normal	102	13080	29	35.8	63.5	7.45	normal	11.7	6	hyperinflation	8500	improved	5	
44	rajamanikam	44	male	15	No	No	No	No	24	mucoid	No	Yes	nil	Yes	normal	96	13080	28	36.5	68.3	7.43	normal	13.1	6	hyperinflation	6800	improved	6	
45	muthukrishnan	46	male	14	No	No	No	No	26	mucoid	No	Yes	nil	Yes	normal	110	13070	34	37.2	63.7	7.42	normal	12.6	30	hyperinflation	11200	improved	9	
46	vanitha	45	female	12	No	No	No	No	0	mucoid	No	Yes	nil	Yes	normal	90	12080	38	36.7	62.5	7.41	normal	10.1	26	hyperinflation	5700	improved	8	
47	vendamani	52	female	14	No	No	No	No	0	mucoid	No	Yes	nil	Yes	normal	96	13080	34	34.8	67.3	7.42	normal	11.1	26	hyperinflation	6800	improved	8	
48	arulmani	62	male	15	No	No	No	No	34	mucoid	No	Yes	nil	Yes	normal	102	13080	29	28.5	63.6	7.42	normal	12.1	6	hyperinflation	7300	improved	5	
49	revathy	48	female	14	No	No	No	No	0	mucoid	No	Yes	nil	Yes	normal	96	11080	34	29.4	68.4	7.37	normal	11.1	26	hyperinflation	7200	improved	9	
50	natesan	57	male	12	No	No	No	No	34	mucopurulent	No	Yes	nil	Yes	normal	102	12080	32	31.2	69.3	7.38	normal	12.3	36	hyperinflation	12300	improved	12	
51	kumar	64	male	15	No	No	No	No	0	mucoid	No	Yes	nil	Yes	normal	92	12080	28	33.5	62.7	7.39	normal	11.2	6	hyperinflation	8700	improved	6	
52	murugan	61	male	10	No	No	No	No	32	mucoid	No	Yes	nil	Yes	normal	94	13080	36	32.6	64.8	7.36	normal	11.4	26	hyperinflation	8600	improved	8	
53	mohammed nisha	56	male	13	No	No	No	No	36	mucoid	No	Yes	nil	Yes	normal	96	13080	36	35.3	63.7	7.36	normal	13.2	26	hyperinflation	5600	improved	10	
54	raman	62	male	8	No	No	No	No	39	mucoid	No	Yes	nil	Yes	normal	90	11080	30	38.4	67.3	7.37	normal	11.4	6	hyperinflation	6400	improved	6	
55	ramesh	57	male	14	No	No	No	No	34	mucoid	No	Yes	nil	Yes	normal	89	11080	32	26.9	69.3	7.37	normal	11.4	26	hyperinflation	6700	improved	8	
56	selvam	56	male	13	No	No	No	No	34	mucoid	No	Yes	nil	Yes	normal	106	12090	27	29.5	65.7	7.38	normal	11.3	6	hyperinflation	7600	improved	5	
57	bama	43	female	9	No	No	No	No	0	mucopurulent	No	Yes	nil	Yes	normal	94	11080	34	30.6	65.8	7.38	normal	11.2	26	hyperinflation	5800	improved	10	
58	anjalai	58	female	20	No	No	No	No	0	mucoid	No	Yes	nil	Yes	normal	94	11070	29	35.7	67.3	7.39	normal	11.3	6	hyperinflation	7800	improved	5	
59	abibula	54	male	23	No	No	No	No	28	mucoid	No	Yes	nil	Yes	normal	102	11080	32	37.6	64.7	7.39	normal	12.3	26	hyperinflation	8900	improved	12	
60	ganesan	58	male	30	No	No	No	No	32	mucoid	No	Yes	nil	Yes	normal	92	11070	28	38.9	68.3	7.37	normal	12.1	6	hyperinflation	8200	improved	6	
61	muthukrishnan	53	male	25	No	No	No	No	0	mucoid	No	Yes	nil	Yes	normal	94	11070	29	30.2	64.6	7.41	normal	12.3	6	hyperinflation	6700	improved	5	
62	pusharani	62	male	12	No	No	No	No	32	mucoid	No	Yes	nil	Yes	normal	104	12080	36	40.2	67.4	7.41	normal	12.7	26	hyperinflation	6900	improved	8	
63	chandran	62	male	10	No	No	No	No	35	mucoid	Yes	Yes	nil	Yes	normal	108	13090	40	41.6	68.3	7.41	normal	13.2	26	hyperinflation	8700	improved	10	
64	mani	45	male	16	No	No	No	No	20	mucoid	No	Yes	nil	Yes	normal	97	13090	27	42.5	65.3	7.37	normal	11.3	6	hyperinflation	8300	improved	5	
65	ugenpaul	58	male	14	No	No	No	No	30	mucoid	No	Yes	nil	Yes	normal	102	11080	32	45.2	67.9	7.36	normal	11.4	26	hyperinflation	7300	improved	9	
66	sathya	47	female	24	No	No	No	No	0	mucoid	No	Yes	nil	Yes	normal	103	13090	38	41.3	63.5	7.37	normal	11.3	26	hyperinflation	11200	improved	11	
67	madappan	57	male	26	No	No	No	No	32	mucoid	No	Yes	nil	Yes	normal	102	11080	32	40.5	67.8	7.38	normal	11.2	26	hyperinflation	7400	improved	6	
68	govindasamy	62	male	20	No	No	No	No	34	mucoid	No	Yes	nil	Yes	normal	102	13090	36	37.3	65.8	7.39	normal	12.3	26	hyperinflation	6200	improved	10	
69	arokiyamani	56	male	16	No	No	No	No	52	mucoid	No	Yes	nil	Yes	normal	98	12070	28	38.4	63.5	7.38	normal	11.2	6	hyperinflation	6500	improved	7	
70	mary	49	female	10	No	No	No	No	0	mucoid	No	Yes	nil	Yes	normal	107	13080	38	39.5	67.4	7.36	normal	11.4	26	hyeprinflation	6300	improved	9	
71	narayanan	54	male	25	No	No	No	No	34	mucoid	No	Yes	nil	Yes	normal	110	12080	34	36.4	68.3	7.38	normal	12.1	26	hyperinflation	6700	improved	9	
72	rajendren	51	male	10	No	No	No	No	25	mucoid	No	Yes	nil	Yes	normal	98	11080	29	37.4	69.2	7.41	normal	11.3	6	hyperinflation	5400	improved	6	
73	vasudevan	57	male	15	No	No	No	No	36	mucopurulent	No	Yes	nil	Yes	normal	105	13090	36	38.4	62.6	7.42	normal	12.4	36	hyperinflation	13200	improved	14	
74	ravi	62	male	21	No	No	No	No	31	mucoid	No	Yes	nil	Yes	normal	101	12090	32	38.4	67.4	7.41	normal	11.2	26	hyperinflation	8700	improved	8	
75	joshi	49	female	15	No	No	No	No	0	mucoid	No	Yes	nil	Yes	normal	98	12080	32	30.1	63.7	7.42	normal	11	26	hyperinflation	8200	improved	10	
76	venkat	56	male	18	No	No	No	No	32	mucoid	No	Yes	nil	Yes	normal	108	12080	39	29.5	63.9	7.43	normal	11.4	26	hyperinflation	7500	improved	11	
77	veni	52	female	10	No	No	No	No	0	mucoid	No	Yes	nil	Yes	normal	90	11080	28	31.5	67.3	7.44	normal	11.2	6	hyperinflation	8100	improved	6	
78	stephen	52	male	10	No	No	No	No	0	mucoid	No	Yes	nil	Yes	normal	90	11080	27	33.8	64.8	7.45	normal	11.2	6	hyperinflation	8300	improved	5	

79	sumathi	56	male	56	No	No	No	No	31	mucoid	No	Yes	nil	Yes	normal	102	12080	34	36.4	67.9	7.38	normal	12.1	26	hyperinflation	7300	improved	9	
80	bharathi	52	female	13	No	No	No	No	0	mucoid	No	Yes	nil	Yes	normal	92	11080	34	37.4	63.5	7.39	normal	11.4	26	hyperinflation	6800	improved	11	
81	chakaravarthi	56	male	14	No	No	No	No	35	mucoid	No	No	nil	Yes	normal	96	12080	32	38.6	68.3	7.38	normal	11.2	26	hyperinflation	5600	improved	9	
82	munniyan	56	male	22	No	No	No	No	32	mucoid	No	Yes	nil	Yes	normal	108	11070	34	36.7	67.4	7.37	normal	11.3	26	hyperinflation	8900	improved	9	
83	pushpha	45	female	14	No	No	No	No	0	mucoid	No	Yes	nil	Yes	normal	92	11080	26	41.3	69.3	7.36	normal	11.2	6	hyperinflation	5400	improved	6	
84	prema	46	female	10	No	No	No	Yes	0	mucoid	No	Yes	nil	Yes	normal	102	11070	34	40.3	63.7	7.38	normal	11.2	26	hyperinflation	7500	improved	9	
85	krishnan	52	male	26	No	No	No	No	30	mucoid	No	Yes	nil	Yes	normal	98	11080	27	40.2	69.2	7.39	normal	11.2	6	hyperinflation	8200	improved	5	
86	shankar	57	male	10	No	No	No	No	30	mucopurulent	No	Yes	nil	Yes	normal	102	11070	34	41.3	64.7	7.36	normal	10.2	26	hyperinflation	7100	improved	10	
87	ambal	49	female	12	No	No	No	No	0	mucoid	No	Yes	nil	Yes	normal	104	12080	36	26.7	68.1	7.41	normal	12.3	26	hyperinflation	7500	improved	10	
88	kavitha	56	female	20	No	No	No	No	0	mucopurulent	No	Yes	nil	Yes	normal	112	12080	40	37.2	67.8	7.4	normal	11.4	36	hyperinflation	12400	improved	13	
89	mathin	56	male	20	No	No	No	No	0	mucoid	No	Yes	nil	Yes	normal	92	11080	26	38.9	63.4	7.42	normal	12.3	6	hyperinflation	7200	improved	5	
90	shanmugam	57	male	21	No	No	No	No	34	mucoid	No	Yes	nil	Yes	normal	90	12090	27	34.6	67.3	7.41	normal	13.2	6	hyperinflation	6500	improved	5	
91	lakshmi	46	female	14	No	No	No	No	0	mucoid	No	Yes	nil	Yes	normal	93	11070	28	32.4	68.3	7.42	normal	11.5	6	hyperinflation	8400	improved	6	
92	settu	54	male	35	No	No	No	No	28	mucoid	No	Yes	nil	Yes	normal	94	11080	30	33.6	69.2	7.45	normal	11.2	6	hyperinflation	7800	improved	5	
93	adhimoolam	57	male	20	No	No	No	No	32	mucoid	No	Yes	nil	Yes	normal	94	12090	29	31.5	67.8	7.37	normal	11.7	6	hyperinflation	11000	improved	6	
94	annai	52	female	10	No	No	No	No	0	mucoid	No	Yes	nil	Yes	normal	95	11080	26	30.4	69.3	7.36	hyperinflation	11.3	6	hyperinflation	11000	improved	5	
95	kanagaraj	52	male	12	No	No	No	No	32	mucoid	No	Yes	nil	Yes	normal	102	12090	36	38.5	65.2	7.38	normal	10.2	26	hyperinflation	6400	improved	9	
96	latha	47	female	13	No	No	No	No	0	mucoid	No	Yes	nil	Yes	normal	98	11080	29	41.3	71.4	7.38	normal	11	6	hyperinflation	8700	improved	5	
97	nalini	48	female	14	No	No	No	No	0	mucoid	Yes	Yes	nil	Yes	normal	102	11080	34	45.2	69.2	7.36	normal	11.2	26	hyperinflation	10200	improved	8	
98	rajammal	56	female	10	No	No	No	No	0	mucoid	No	Yes	nil	Yes	normal	92	11080	27	41.3	67.4	7.39	normal	11.3	6	hyperinflation	6700	improved	5	
99	marappan	69	male	21	No	No	No	No	38	mucopurulent	No	Yes	nil	Yes	normal	110	13090	34	42.3	68.3	7.4	normal	11.2	36	hyperinflation	13400	improved	14	
100	munniyan	56	male	10	No	No	No	No	34	mucoid	Yes	Yes	nil	Yes	normal	103	11080	32	43.2	69.2	7.42	normal	10.2	38	hyperinflation	12700	improved	12	
101	sarathy	48	female	10	No	No	No	No	0	mucopurulent	No	Yes	nil	Yes	normal	98	11080	28	37.3	62.5	7.44	normal	11.3	26	hyperinflation	12500	improved	10	
102	pappathi	52	female	10	No	No	No	No	0	mucoid	No	No	nil	Yes	normal	96	11080	28	38.5	61.8	7.37	normal	11.2	6	hyperinflation	5800	improved	6	
103	arun	56	male	15	No	No	No	No	34	mucoid	Yes	Yes	HT	Yes	normal	110	14080	35	40.1	64.3	7.38	normal	11.2	36	hyperinflation	7300	improved	12	
104	geetha	56	female	10	No	No	No	No	0	mucoid	No	Yes	nil	Yes	normal	96	11080	28	42.5	67.3	7.39	normal	11.3	6	hyperinflation	5600	improved	6	
105	ramachandren	62	male	14	No	No	No	No	31	mucoid	No	Yes	nil	Yes	normal	98	11080	30	34.5	64.5	7.37	normal	11.2	6	hyperinflation	7800	improved	5	
106	suresh	57	male	13	No	No	No	No	0	mucoid	No	Yes	nil	Yes	normal	98	11080	28	45.3	64.5	7.38	normal	11	6	hyperinflation	5600	improved	5	
107	palani	45	male	12	No	No	No	No	25	mucopurulent	No	Yes	nil	Yes	normal	102	11080	28	35.2	68.3	7.42	normal	11.2	26	hyperinflation	9800	improved	10	
108	chandren	56	male	12	No	No	No	No	30	mucoid	No	Yes	nil	Yes	normal	98	13090	34	36.8	67.8	7.43	normal	11.2	26	hyperinflation	8700	improved	10	
109	bhavani	47	female	12	No	No	No	No	0	mucoid	No	Yes	nil	Yes	normal	96	11080	34	34.7	69.3	7.44	normal	11.7	26	hyperinflation	9500	improved	10	
110	krishnan	62	male	12	No	No	No	No	36	mucoid	Yes	Yes	nil	Yes	normal	110	11080	34	34.5	67.4	7.45	normal	11.5	36	hyperinflation	9700	improved	13	
111	senthil	62	male	10	No	No	No	No	34	mucoid	No	Yes	nil	Yes	normal	104	12080	32	31.1	65.3	7.36	normal	10.2	26	hyperinflation	7800	improved	10	
112	lakshmi	58	female	12	No	No	No	No	0	mucoid	No	Yes	nil	Yes	normal	94	11070	29	37.2	67.4	7.37	normal	12.3	6	hyperinflation	8400	improved	5	
113	bharani	64	male	14	No	No	No	No	34	mucoid	No	Yes	nil	Yes	normal	104	13080	38	38.2	68.2	7.43	normal	10.3	26	hyperinflation	11800	improved	10	
114	kannan	62	male	18	No	No	No	No	0	mucoid	No	Yes	nil	Yes	normal	92	11070	30	45.3	68.3	7.39	normal	10.9	6	hyperinflation	7400	improved	6	
115	krishnaveni	52	female	15	No	No	No	No	0	mucoid	No	Yes	nil	Yes	normal	90	11070	27	31.2	69.3	7.4	normal	10.8	6	hyperinflation	5600	improved	5	
116	harichandran	56	male	20	No	No	No	No	35	mucopurulent	No	Yes	nil	Yes	normal	105	13090	32	34.2	67.8	7.41	normal	11.4	46	hyperinflation	13700	improved	14	
117	madhavan	56	male	25	No	No	No	No	40	mucoid	Yes	Yes	nil	Yes	normal	104	11080	32	35.5	67.8	7.42	normal	12.3	46	hyperinflation	6700	improved	12	
118	vendhan	61	male	28	No	No	No	No	39	mucopurulent	No	Yes	nil	Yes	normal	108	11070	36	34.4	64.7	7.38	normal	12.3	46	hyperinflation	13300	improved	15	
119	balakrishnan	58	male	20	No	No	No	No	0	mucoid	No	Yes	nil	Yes	normal	94	11070	29	34.6	65.7	7.37	normal	11.2	6	hyperinflation	11200	improved	6	
120	shankari	49	female	13	No	No	No	No	0	mucoid	No	Yes	nil	Yes	normal	88	11080	26	36.7	64.7	7.45	normal	11.4	6	hyperinflation	9200	improved	5	
121	ganthi	56	female	14	No	No	No	No	0	mucoid	No	Yes	nil	Yes	normal	84	11080	28	37.3	68.3	7.4	normal	10.4	6	hyperinflation	6200	improved	5	
122	anjali	58	female	15	No	No	No	No	0	mucopurulent	No	Yes	DM	Yes	normal	108	11070	38	36.9	67.2	7.41	normal	11.2	4	pneumonia with hyperinflation	14500	failure	31	NECROTISING PNEUMONIA
123	elumalai	54	male	25	No	No	No	No	45	mucoid	Yes	Yes	nil	Yes	normal	121	14070	38	35.7	65.7	7.42	normal	13.5	1	hyperinflation	7800	failure	28	CLAUSTROPHOBIA
124	krishnan	62	male	14	No	No	No	No	35	mucoid	Yes	Yes	nil	Yes	normal	110	13090	36	32.3	67.8	7.37	normal	12.3	4	hyperinflation	5400	failure	10	MECHANICALLY VENTILATED-DEATH
125	ganesan	56	male	30	No	No	No	No	38	mucoid	No	Yes	corpulmonale	Yes	normal	110	14070	38	37.8	69.2	7.38	p pulmonale	11.3	58	hyperinflation	9600	failure	25	ASSOCIATED CORPULMONALE
126	shangari	52	female	12	No	No	No	No	0	mucoid	No	Yes	nil	Yes	normal	98	11080	34	36.4	65.7	7.39	normal	11.2	1	hyperinflation	7800	failure	30	CLAUSTROPHOBIA
127	arumugam	57	male	14	No	No	No	No	38	mucoid	No	Yes	nil	Yes	normal	112	12080	40	32.3	64.7	7.38	normal	11.4	1	hyperinflation	10200	failure	29	CLAUSTROPHOBIA
128	rajan	56	male	18	No	No	No	No	30	mucopurulent	No	Yes	DM	Yes	normal	108	13090	38	37.4	68.3	7.36	normal	11.3	4	pneumonia with hyperinflation	12800	failure	31	PARAPNEUMONIC EFFUSION
129	sumathi	56	female	12	No	No	No	No	0	mucoid	No	Yes	nil	Yes	normal	108	13080	34	38.4	64.6	7.35	normal	10.3	1	hyperinflation	9800	failure	30	CLAUSTROPHOBIA
130	kamatachi	56	female	25	No	No	No	No	0	mucoid	No	Yes	corpulmonale	Yes	normal	124	13080	36	38.4	62.7	7.39	p pulmonale	12.8	68	hyperinflation with cardiomegaly	8600	failure	28	ASSOCIATED CORPULMONALE
131	saravanan	54	male	15	No	Yes	No	Yes	42	mucoid	Yes	Yes	CAD	Yes	normal	118	14080	38	36.3	61.7	7.41	normal	13.6	4	hyperinflation	8500	failure	18	ACUTE MYOCARDIAL INFARCTION

Role of clinical and biochemical parameters for predicting outcome of non - invasive ventilation in patients with acute exacerbation of chronic obstructive pulmonary disease

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Chennai-600 001

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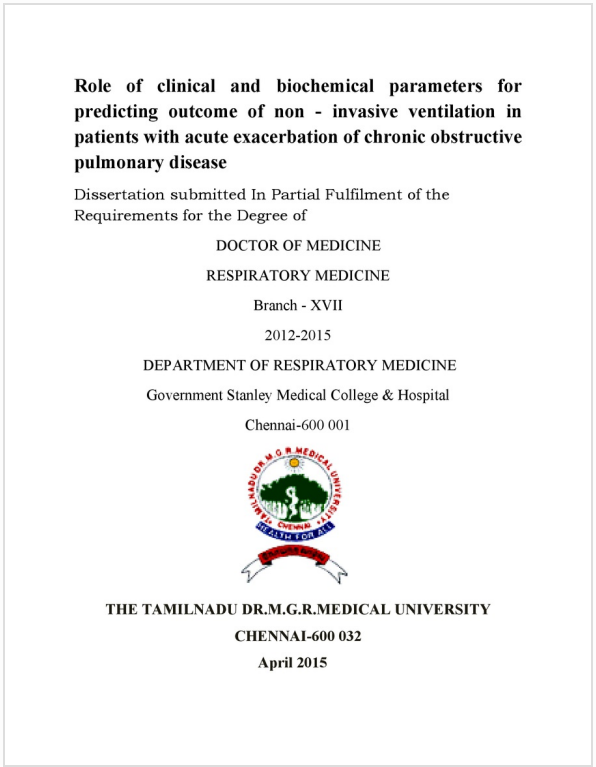

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